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Compressed Air Magazine

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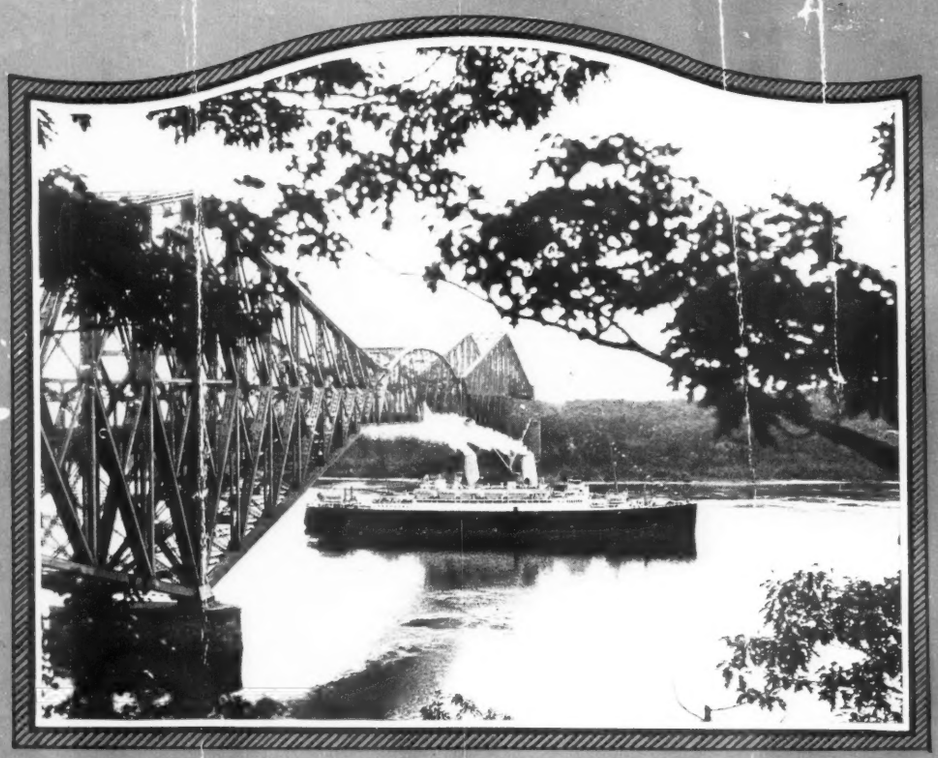

THE FAMOUS QUEBEC BRIDGE WHICH SPANS THE BROAD ST. LAWRENCE IS SPRAY PAINTED PERIODICALLY TO PREVENT FORMATION OF RUST

Colorado Portland Cement Mill Model of Its Kind
C. H. Vivian

Refrigeration Essential in Candy-Making
W. J. McCloskey

Second Musconetcong Tunnel Nears Completion
R. G. Skerrett

Blowing Beverage Bottles By Machine
S. G. Roberts

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n-762-LC

Breaking ice from city street using Waukesha engined I-R Compressor

Out of the Gutter

Ice in the gutter causes flooded streets with the first thaw. Progressive street departments have demonstrated that portable compressed air plants and pneumatic tools as shown above, do six times as much work as hand pick methods and at less cost. Waukesha Engines are used in all I-R Portable compressors.

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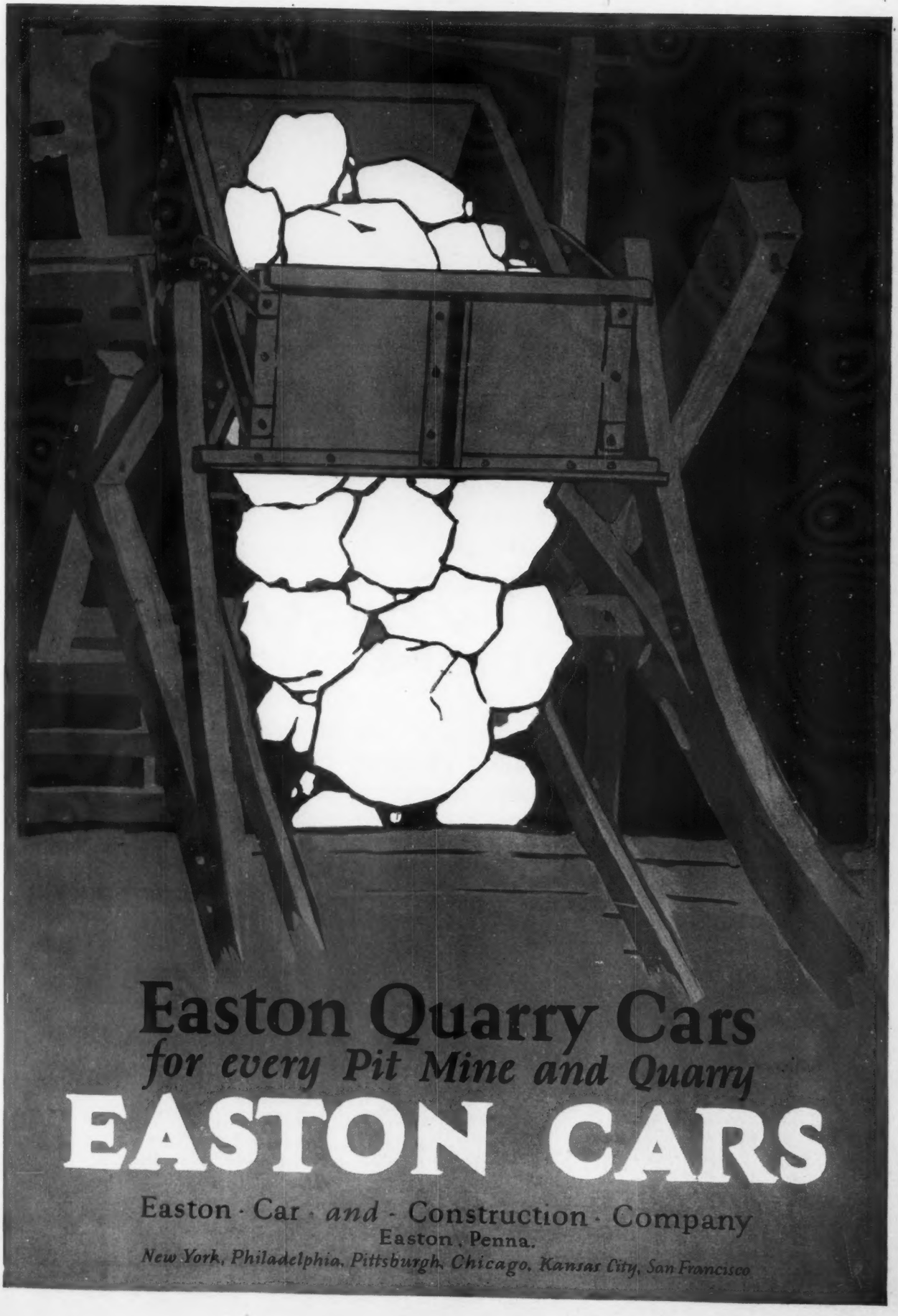
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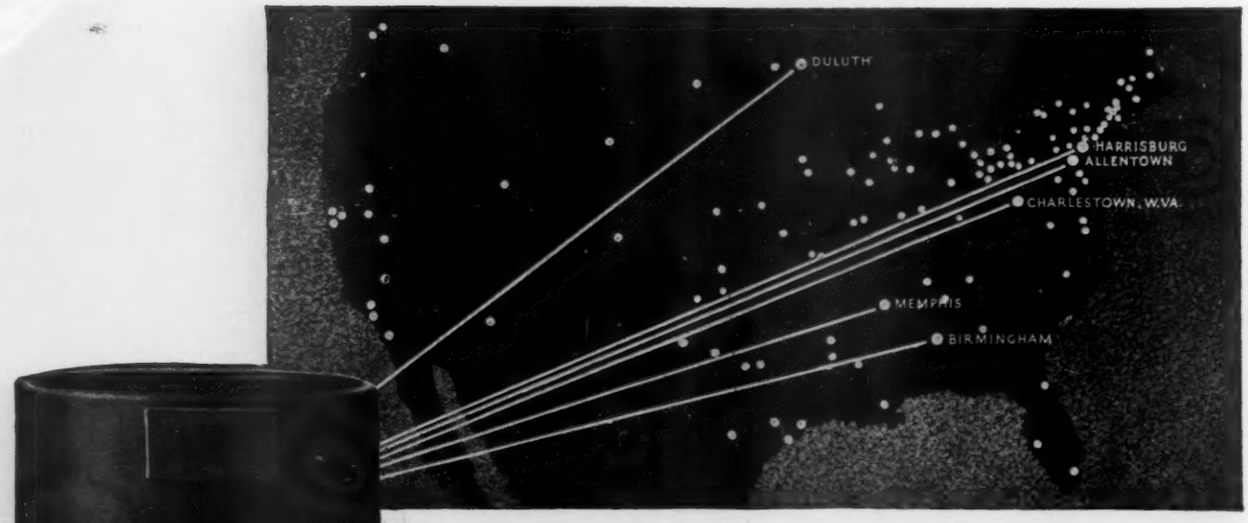

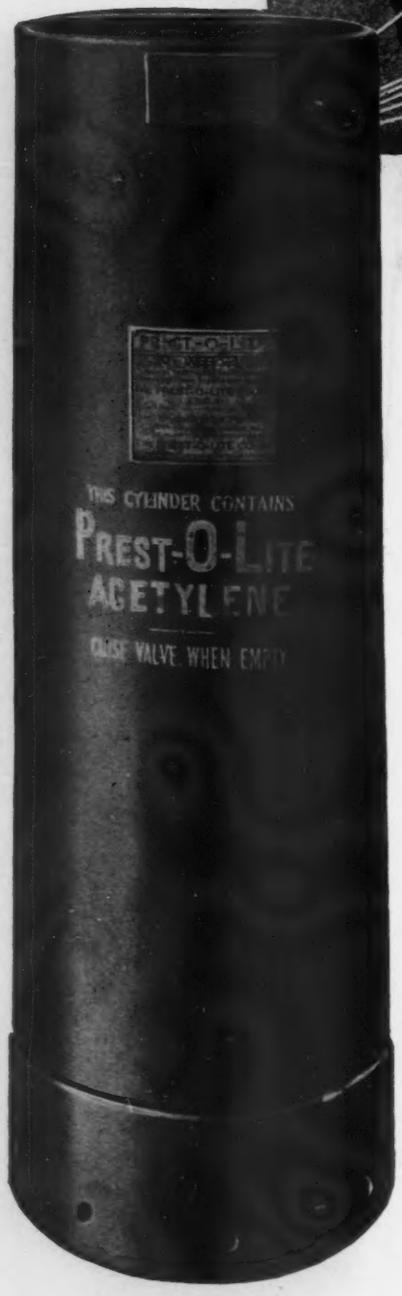

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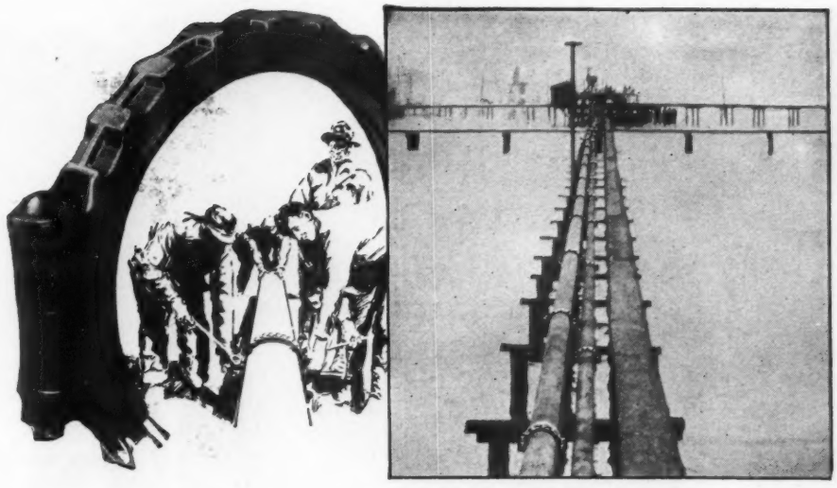

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THIS oil line at Maracaibo connected with Victaulic Couplings is constantly subjected to distortions as the dock on which it is laid weaves under the action of waves and tide. Its working pressure is 900 pounds. The temperature of this loading line varies under the tropic sun of midday and the cool nights. In spite of these severe service conditions, not a coupling has leaked since the line went into service.

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Victaulic Couplings combine a high degree of flexibility with freedom from leaks. They care for contraction and expansion of the lengths they connect and make it entirely unnecessary to use special swing joints or expansion bends. They assure a strain-free line that neither pulls apart nor buckles when temperature changes cause the pipe lengths to contract or expand.

Victaulic Couplings make it possible to lay pipe lines at least cost, at record speed and with unskilled labor. Their use has been standardized by many leading companies in the petroleum industry. Gas, water, mining and sanitary engineers specify them for a wide range of uses. They are all-purpose couplings for every joint on the line—unequalled for economy in pipe line construction and immune to injury under service conditions that breed trouble for other types of lines.

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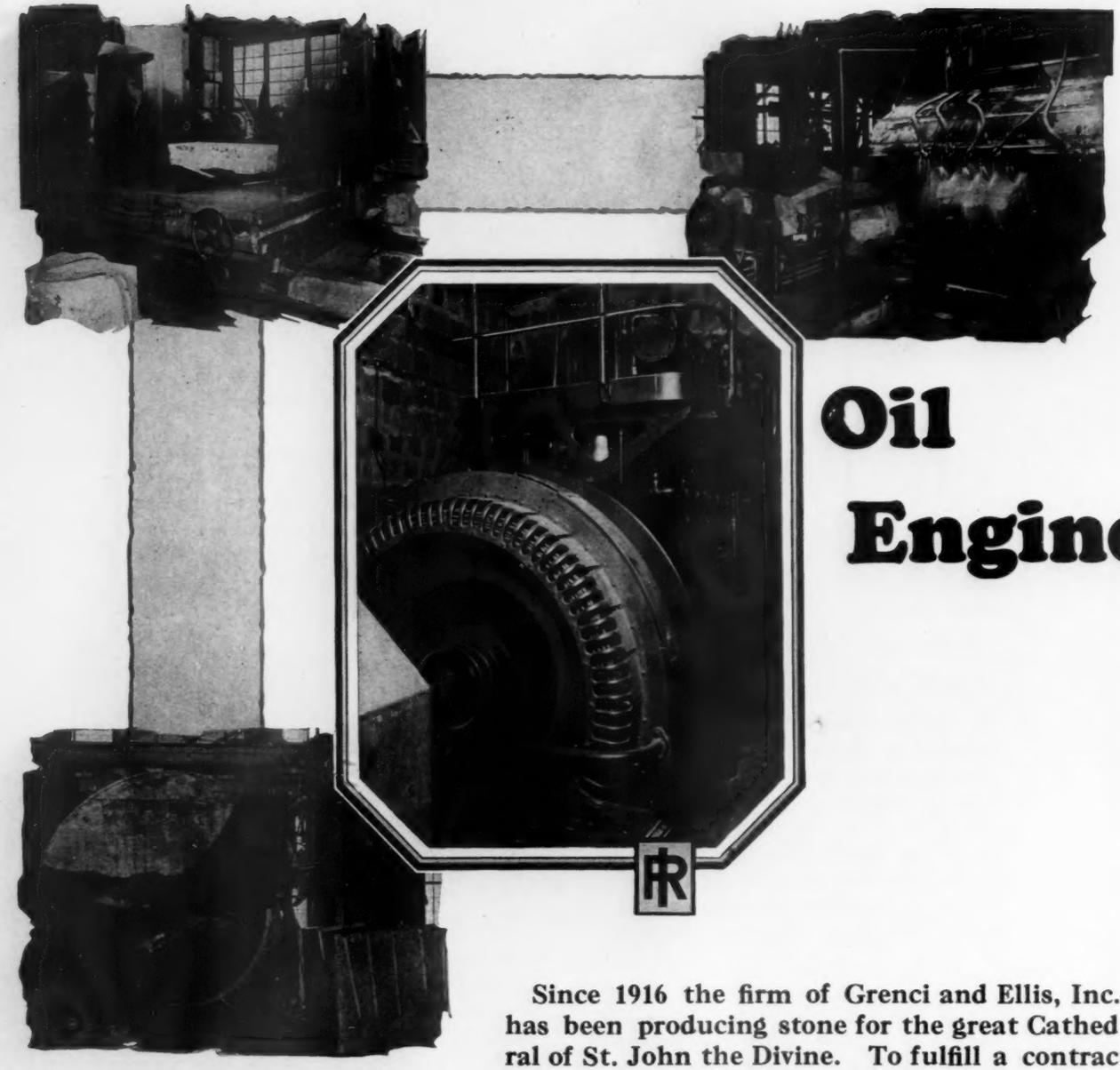

Oil Engines

One of the oil engine generating units furnishing power for two Parker rotary saws, six edgers, two gang saws, six 10-ton cranes, and various pumps, grindstones, suction fans, etc. There are two of these PR vertical oil engine units.

Since 1916 the firm of Grenci and Ellis, Inc., has been producing stone for the great Cathedral of St. John the Divine. To fulfill a contract of this kind profitably, the utmost in mechanical efficiency and low power cost is necessary. To obtain this economical power, the plant was converted from steam to oil engine equipment. Ingersoll-Rand Solid-Injection Diesel Engines were chosen.

The equipment consists of two 250-hp. oil engines direct-connected to A. C. generators, and two 110-hp. direct-connected oil engine com-

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pressor units that furnish air for the drills, etc. For 868,420 horsepower-hours of service, the total outlay for fuel and lubricating oil has been only $4,494.28. This charge amounts to but $0.00518 per horsepower-hour.

The oil engine compressors furnish air for all the rock drills in the quarry. They also operate the pneumatic surfacers and the tools in the cutting shed. There are seventy men in this shed, and each man uses an air-driven tool.

The replacement of the piston drill by the hammer drill for channeling has effected a tremendous saving in the production of granite. This cost has now been further reduced by the conversion from steam to oil engine equipment.

142-SOE

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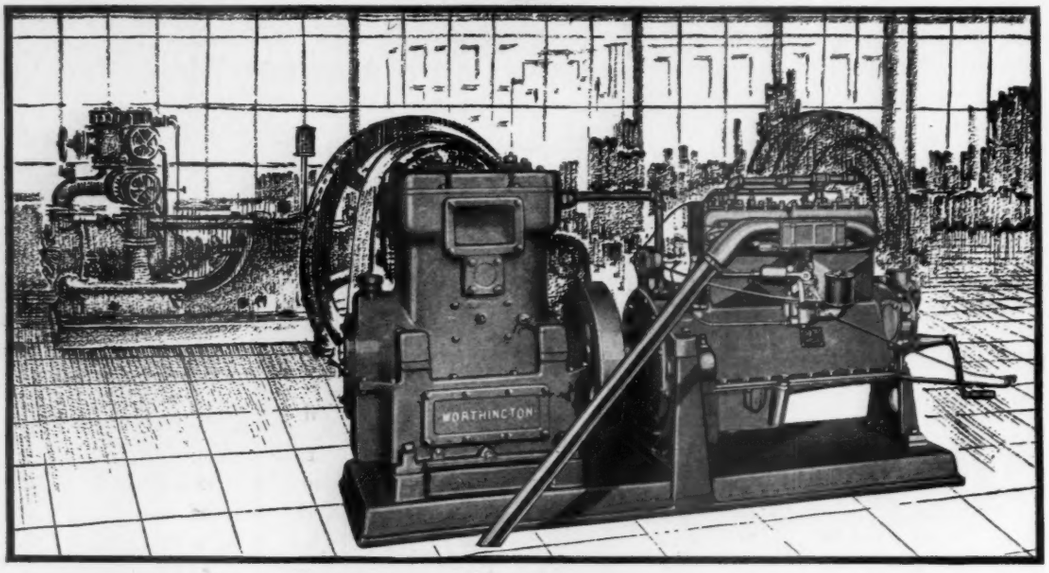

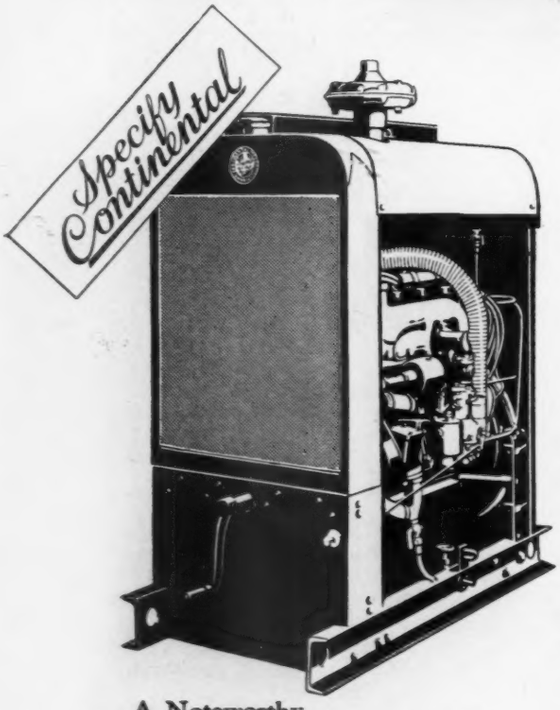

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In the making of artificial ice the Artesian Ice Company, Ind., Ft. Madison, Iowa use a Worthington Air Compressor direct coupled to a model L4 Continental motor rated at 31 h. p.

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Continental Motors

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Charles Goodyear, from a contemporary portrait

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He met the jeers of the world with a faith that neither disaster nor seeming disgrace could conquer.
He laid upon the altar of his work all the dear things of life—health, family, friends, fortune, happiness.
He was cast into prison for debt.
He felt himself "appointed of God."
He discovered the vulcanization of rubber.
His name was Charles Goodyear.

IN the immense and farflung industrial structure that is Goodyear today, an army of workers labors to enlarge Charles Goodyear's discovery.

In cities that he never saw—quite possibly of which he could not even dream—and in an enterprise he did not found, his spirit abides where his name finds greatest honor.

Deservedly the greatest name in rubber in the beginning, through the work of the man, Goodyear is today no less deservedly the greatest name in rubber through the work of the institution which followed the path he pioneered.

The name Goodyear is greatest in invention

The work of Goodyear, the institution, has been noteworthy not only in the case of tires, but equally in those industrial products whose duty is the conservation of energy and the transmission of power.

In the matter of belting, for example, the quality of Goodyear manufacture has produced a value and a usefulness that have won decisive leadership for Goodyear conveyor belts.

The same fixed principle of use and value is rapidly winning a comparable position for all Goodyear mechanical rubber goods—power transmission belting for industry and for the farm; hose for every imaginable purpose, from garden sprinkling to dredging; a long line of moulded goods; packing for pipes and engines; blankets and rollers for printers and lithographers, rubber bands, and railroad supplies.

There is hardly an industrial plant in the world that does not know the name of Goodyear.

Wherever that name is known it signifies the highest quality in materials and workmanship, and also a scientific service of specification, installation, and conservation. This service of analysis—called the Goodyear Plant Analysis Plan—is the special duty of the G. T. M.—Goodyear Technical Man.

An expert on rubber mechanical goods for industry, the G. T. M. is trained to combine his knowledge of Goodyear products and what they can do, with your knowledge of what your individual operations require, and to recommend the particular Goodyear product that will do your work at the lowest possible cost.

The name Goodyear is greatest in usefulness

This is a young company—eager, alert, forward-looking—this company that today uses nearly one-seventh of all the crude rubber produced annually on the earth, almost 50% more than is used by any other manufacturer.

It has come along no royal road in its march to leadership, but often through trial and travail like that which Charles Goodyear himself endured.

But it has had his conquering spirit in its heart.

And it has had the devoted service of thousands on thousands of loyal men who respond to that spirit. It has had the trust and good-will of millions of people who have tested its work and word, and found them worthy.

It will keep all these, because it knows whereof they spring.

In the beginning, by force of discovery, Goodyear was the greatest name in rubber.

By force of usefulness, to its own and to all people, Goodyear is the greatest name in rubber today.

GOODYEAR

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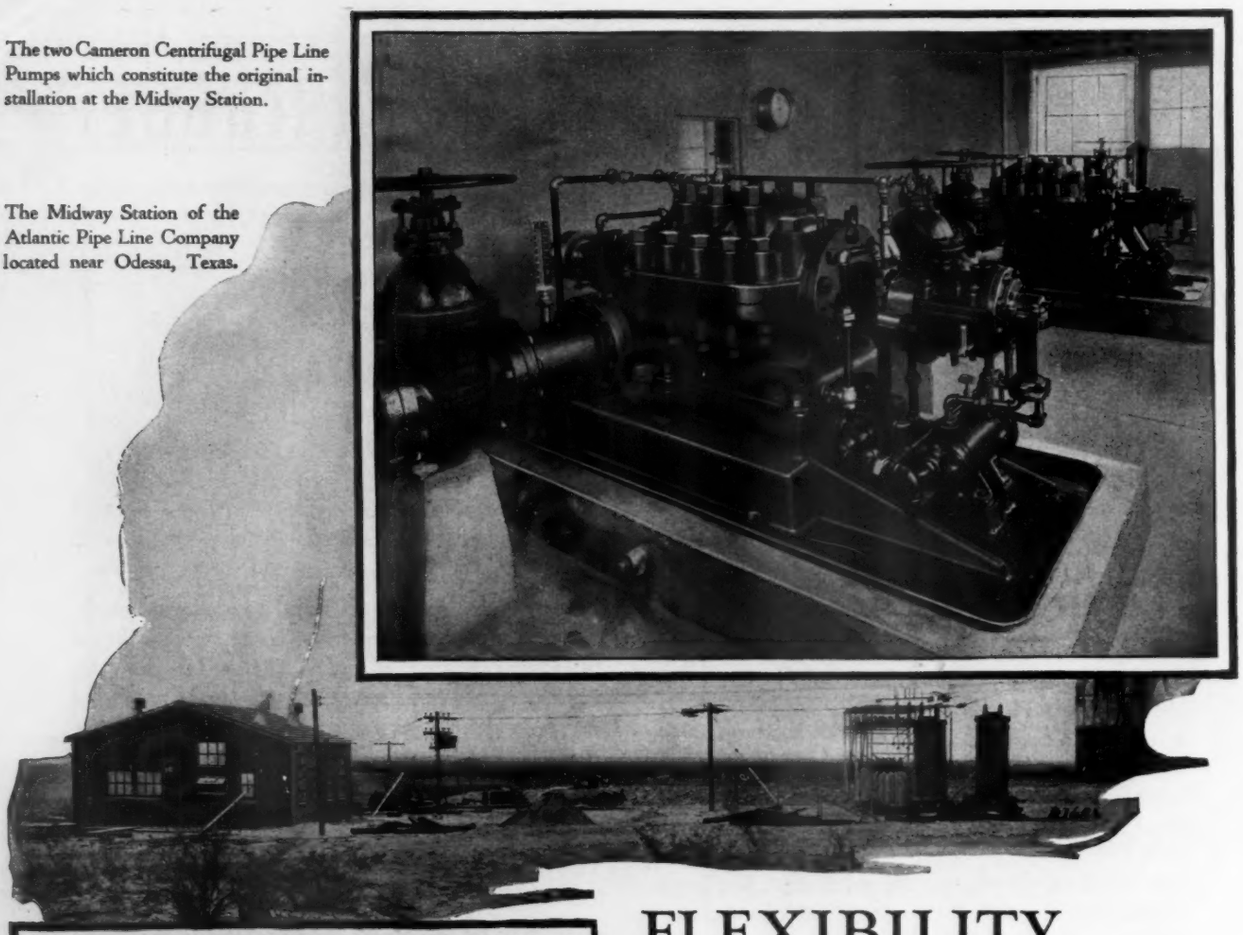
The two Cameron Centrifugal Pipe Line Pumps which constitute the original installation at the Midway Station.

The Midway Station of the Atlantic Pipe Line Company located near Odessa, Texas.



The motor room of the Midway Station. The electric motors are separated from the pumps by means of a steel partition.

FLEXIBILITY

—a feature of Cameron Pipe Line Pumping Plants

When the original Cameron pumping unit was installed at the Midway Station of the Atlantic Pipe Line Company near Odessa, Texas, two No. 5 "HMT" four-stage pumps, running in series, handled 34,000 barrels of oil per day through 10" line.

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"Drilling and Blasting in Some American Metal Mines", 197 pages, is a study of methods in 90 leading mines. It presents in condensed form the results of the work of hundreds of the country's foremost mining engineers. It is arranged and tabulated so that you can find out quickly how others are solving problems that trouble you. The first section of the book gives information about each mine that will enable you to determine which of the operations discussed encounters conditions similar to your own. In the last section are drilling and blasting diagrams showing the position of the holes, order of detonation and size of charges. The third section is composed of indexes that make it possible to locate the information you want quickly and easily.

Either of these books will be forwarded to men in positions involving the use of explosives. Please use the coupon below.

For information on other explosives and blasting supplies, see pages 170 to 172 of the 1928 Keystone Metal Quarry Catalogue.

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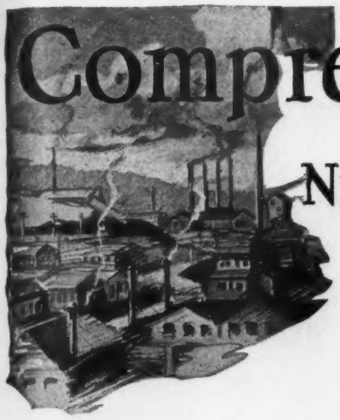

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Compressed Air Magazine Co.
DECEMBER, 1928

New Mill of Colorado Portland Cement Company Model of Its Kind

Pneumatic Conveyor System and Use of Waste Heat for Power Generation Distinguish Plant at Boettcher, Colo.

By C. H. VIVIAN

THE new plant of the Colorado Portland Cement Company, at Boettcher, Colo., is the most modern dry-process cement mill in operation today. Its all-around efficiency and the high quality and uniformity of its product stamp it as an outstanding example of cement-plant engineering. It should be of especial interest to the readers of these pages, because compressed air is a factor of major importance in its operation. It is one of nine plants owned and operated by the Ideal Cement Company of Denver. Three of the mills use the wet process, and six employ the dry process. A tenth plant is now under construction at Saratoga, Ark. It is designed for the wet process.

The Boettcher plant is situated seven miles from Fort Collins and 70 miles north of Denver at the eastern base of the Continental Divide. It is immediately adjacent to deposits of calcareous shales, of the Cretaceous age, which furnish the necessary raw materials. It has a capacity of 3,500 barrels of cement every 24 hours. Natural gas is used for fuel; and all power required, plus a surplus that is sold, is generated from waste heat from the kilns. The mill has been in operation since December, 1927. It represents an investment of approximately $2,000,000; and two years were spent in its construction.

Portland cement is a complex compound in which the calcium-oxide content is around 67 per cent. The problem of manufacture is to so mix the raw materials entering the kilns that the clinker which results from burning or calcination will contain this desired calcium-oxide percentage. The problem is simplified at Boettcher because the raw materials can be quarried to yield essentially the required mix. It is thus comparatively easy to maintain an almost uniform kiln feed.

THERE has been much difference of opinion among cement men in recent years over the merits of wet and dry processes of cement manufacture. Many adherents of the wet process have held that it was far superior to the older method. Another group has maintained that this only appeared to be so because comparisons were being made between modern wet-process plants and somewhat obsolete dry-process plants.

Mr. Paul C. Van Zandt has proved that there is some truth in this, for the new Colorado Portland Cement Company's dry-process mill, designed by him and described in this article, is recognized as exemplifying the latest word in economy and efficiency.

This fact, together with the scarcity of water and other factors, was responsible for the selection of the dry process in preference to the wet process. The same materials that are used at Boettcher have been utilized by the Ideal Cement Company for 25 years at Portland and at Concrete, Colo., so it was known from the start that a product of a high standard of excellence could be turned out.

The shales belong to the Niobrara formation. They occur in stratified beds that dip approximately 20° to the east. The lime content of the various strata shows considerable variation. Those at the western edge of the formation are high in calcium, while those at the eastern limit are low in this element. By drawing from both sections of the quarry simultaneously, it is possible to deliver to the crushers a raw material that requires little correction before entering the kilns. Some of the beds in the center of the formation carry very nearly the desired lime content. The company owns sufficient land to yield material for 100,000,000 barrels of cement by excavating to a depth of only 60 feet.

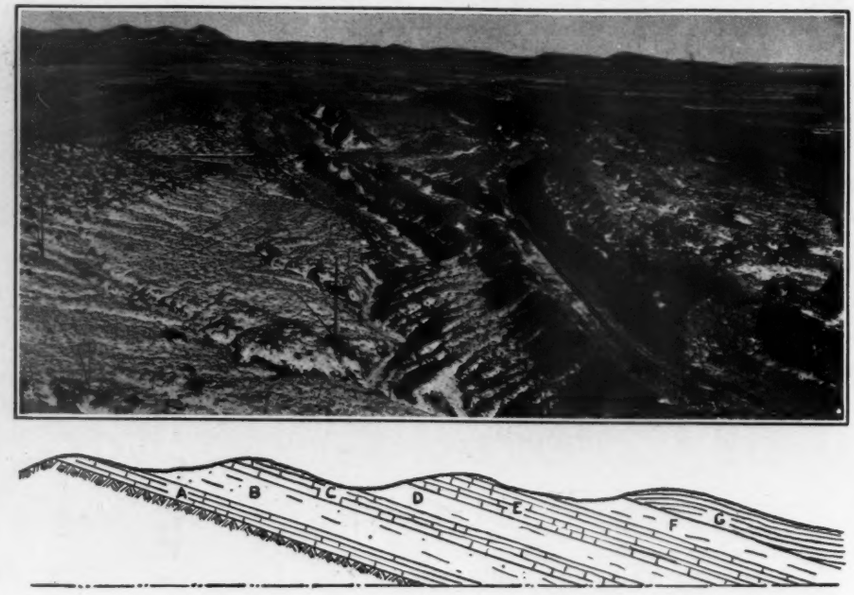
Drilling at the quarry is done with Armstrong well drills. As shot down, the material is sufficiently broken up for handling. It is loaded by a Bucyrus 120-B electric shovel and a Marion 70 steam shovel into Easton 11-cubic-yard, all-steel, pan-type quarry cars, which are hauled to the crushing plant by two standard-gage steam locomotives.

The primary crusher is a roll-type Allis-Chalmers Fairmount, 36x60 inches in size, driven by a Westinghouse 150-hp. motor. From the crusher, the material is elevated to a storage bin, whence it is fed into a Williams mill. Provision is made for sampling the product of this mill; and as it is conveyed by belt to storage tanks it is accurately weighed by passage over a Merrick "Weightometer". Thus both the quantity and the composition of the material in each storage tank are known at all times; and by drawing from two or more tanks simultaneously, the proper mix can be prepared for the kilns. The material is taken from the tanks by means of Schaeffer "Poidometers" which automatically feed a specified quantity on to a conveyor belt.

At this stage in the operations, the material has a maximum size of about 1 inch. The withdrawals from the various tanks are delivered

to a central channel, beneath the floor, where they are thoroughly mixed by means of a continuous chain drag. This drag carries the material into an elevator, which feeds it into the driers. These are steel cylinders, 70 feet long by 7½ feet in diameter, pitched ¾ inch to the running foot. They are rotated at the rate of approximately one revolution per minute, thus tumbling and mixing the material into which a gas flame is played from the lower end of each cylinder.

The dried rock is elevated into tanks from which it is fed into Traylor cylindrical grinding mills, each 26 feet long by 8 feet in diameter, and horizontally placed. Three of the five mills installed are used for grinding raw materials. The other two are for grinding clinker. Each mill has two compartments which are half filled with steel balls of varying sizes, the charge being 120,000 pounds. The raw material enters one end of the mill through a hollow trunnion and leaves the other end ground to the desired fineness. Each mill is direct connected to a 600-hp. synchronous motor of the clutch type. It might be mentioned here that each piece of equipment in the entire mill is operated by its own motor. All electrical machinery is of Westinghouse manufacture. The motors driving the ball mills are separated from the mills by a partition, and are controlled by electricians only. The ball mills are operated at the rate of 18 revolutions per minute. When it is discharged from the mills, the material is so finely divided that from 85 to 90 per cent of it will pass a 200-mesh screen.



Top—Airplane view of the quarry that supplies the Boettcher plant with raw materials. Bottom—In this cross section of the beds, ledge A contains nearly pure limestone; ledges B, D, and F are calcareous shales bearing 55-60 per cent calcium carbonate; ledges C and E, also calcareous shales, contain 75-88 per cent calcium carbonate; and ledge G is high in calcium carbonate with a percentage of iron.

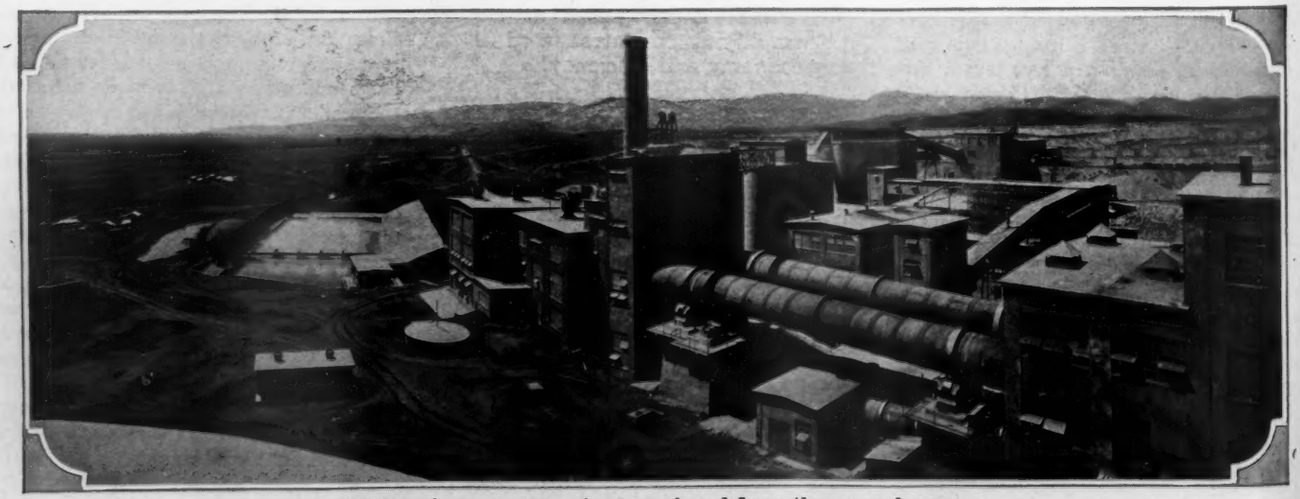
From the time it leaves the Traylor mills until it emerges from the packers as sacked cement, most of the conveying of the material is done by means of compressed air. This is effected through the medium of the Fuller-Kinyon pump system for transporting dry, powdered substances. One of the accompanying illustrations shows a close-up of one of these pumps.

The Fuller-Kinyon pump consists of a horizontally disposed cylinder containing a helical screw of decreasing pitch. This screw is driven by a motor at about 900 revolutions per minute. Material entering at the feed end is in this way given a rather high momentum and, by virtue of the decreasing pitch, is compressed into a sausage-like mass that emerges at the other end. Then it goes into a compartment, approximately 2 inches long, at the end of which air is admitted at 100 pounds pressure—the air passing forward through a number of small openings in a stellited disk or plate. Thus the air stream is finely divided, and, in turn, breaks up the material upon which it impinges. The air and the material flow onward into flanged iron pipe of either 5- or 6-inch diameter, depending upon the capacity of the pump. There the air expands to such an extent that its pressure is reduced to 20 or 15 pounds. The air carries the material along in suspension, the individual particles being of such minute size that they are floated along like so much eiderdown.

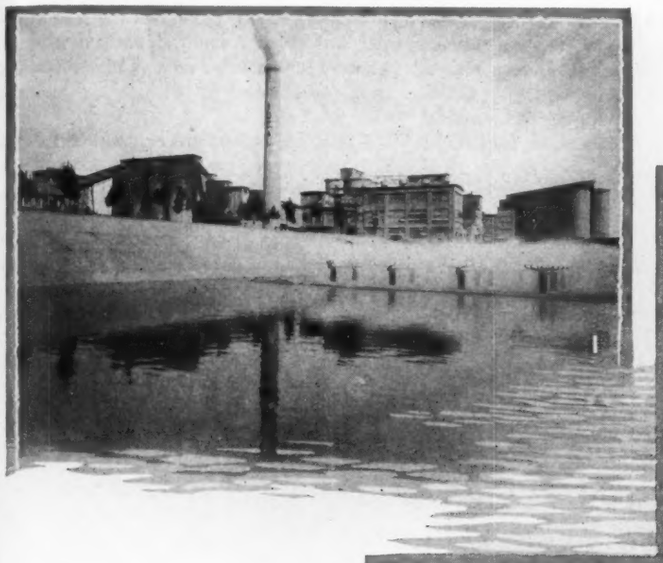
The amount of air admitted is controlled by the number and the size of the openings in the disk; and each pump is supplied with just sufficient air to move the quantity of material which it is designed to handle. At the Boettcher plant there are a number of these pumps, of varying sizes. This system eliminates all dust, since all parts are enclosed. It is more economical than mechanical conveyors, and more efficient. In one instance, the material is transported 647 feet. Pipe bends are stellited to reduce wear.

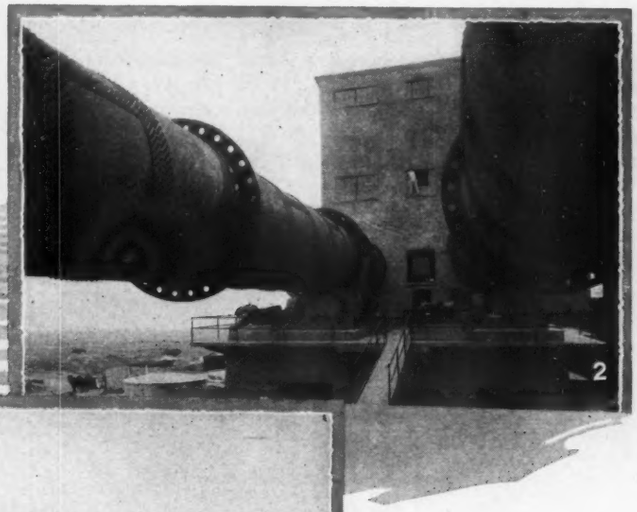
The Fuller-Kinyon equipment is electrically controlled. By merely pushing buttons on the control panel adjacent to each pump, air-operated valves change the routing of the material. Some phases of the system are automatic. For example, if a pump is delivering to one of several tanks, it will divert delivery to another tank when a predetermined amount has been placed in the first tank. There is also a clock control, which diverts material after any desired time interval.

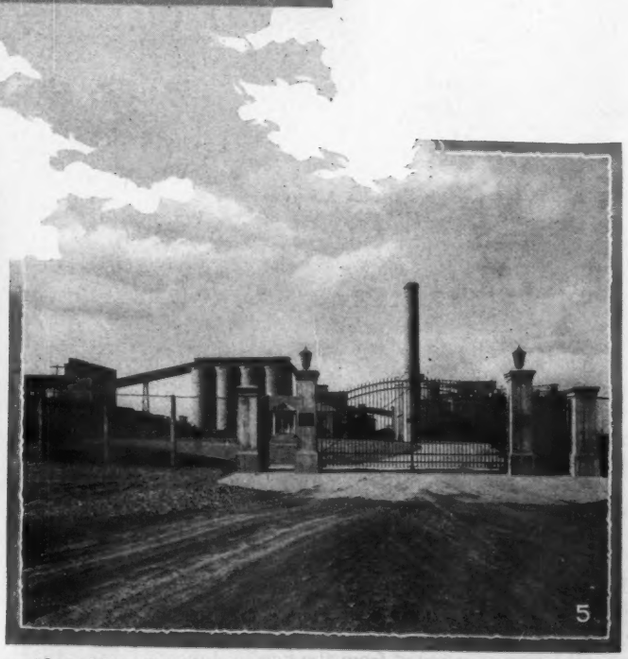
Because of the air demands of this conveying



The main part of the plant, as viewed from the power house.







1—The spray pond used for cooling condenser water. 2—The two outdoor kilns, looking toward the firing ends. 3—View of the Colorado Portland Cement Company's plant at Boettcher, showing cement storage silos at the right. 4—Lawns, trees, and shrubbery add attractiveness to the grounds. 5—The ornamental gateway that guards the approach to the plant.

system and of the other services to which air is put, the mill has an extensive plant for producing compressed air. The original installation consisted of four Ingersoll-Rand Type XCB compressors, each short-belt driven from a 200-hp. motor. These units each have a piston displacement of 1,236 cubic feet per minute. Shortly after the plant began operating, so many advantageous uses were found for air that an Ingersoll-Rand Class PRE-2 compressor was obtained. This machine has the patented 5-step clearance control feature; is driven by a 500-hp. synchronous motor; and has a piston displacement of 3,078 cubic feet per minute. After an initial short test, this compressor was placed in service and was run continuously for 30 days. Under normal conditions, two of the XCB compressors constitute, in effect, stand-by units. The actual output of the five machines is approximately 5,000 cubic feet per minute; and the air leaves the receivers at 100 pounds gage pressure.

The finely ground material from the Traylor mills is conveyed to Sturtevant air separators or, if desired, can be by-passed direct to the blending tanks. There are five air separators: three for raw materials and two for finished cement. By means of centrifugal action, the coarser particles are segregated from the fines and sent back for regrinding.

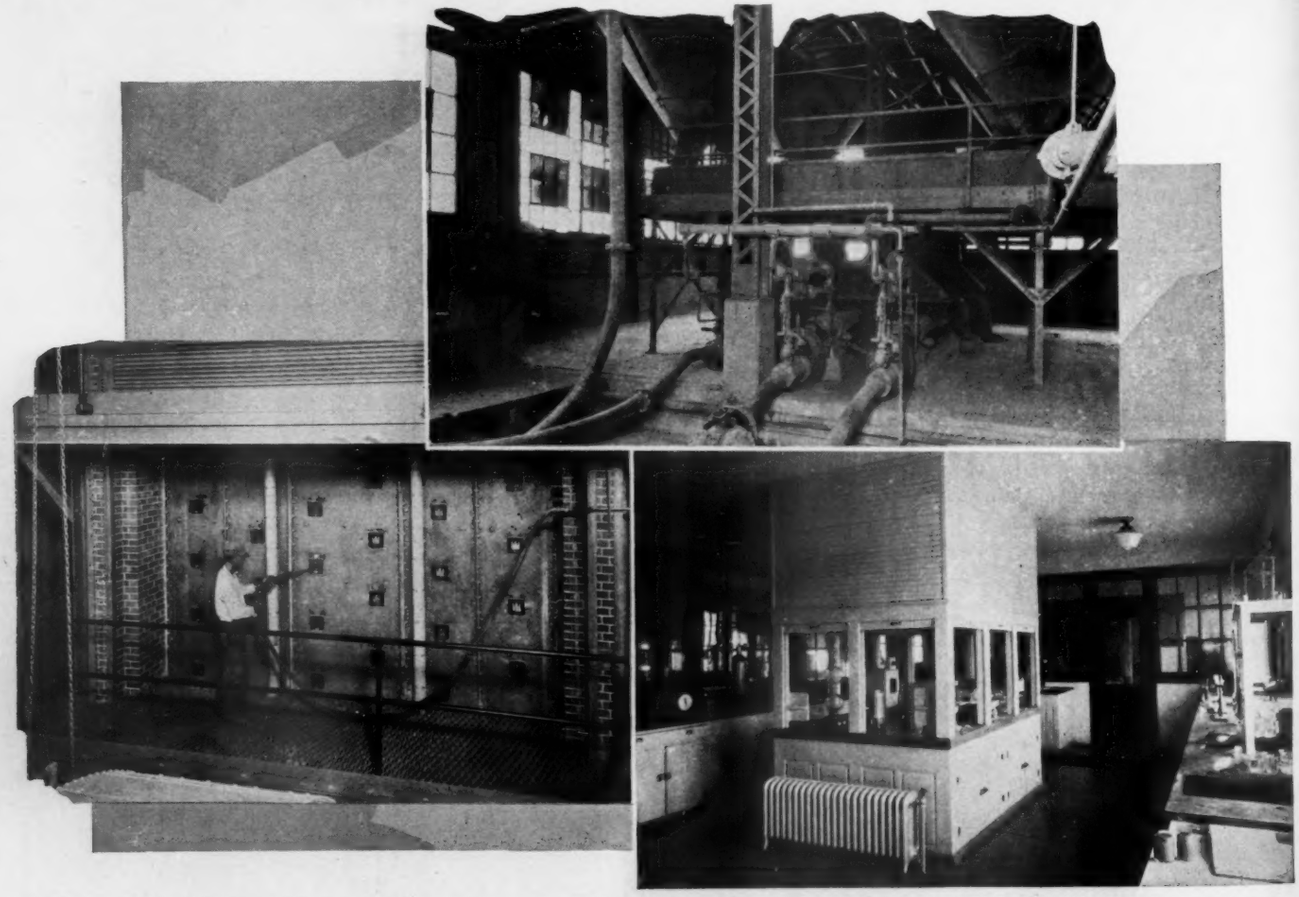
The raw material is automatically switched by the Fuller-Kinyon control board to four blending tanks in turn. Underneath each tank is a Fuller-Kinyon pump. These pumps, which pump twice the kiln capacity at all times, are continually conveying the material to the kiln feed tanks. When these feed tanks are full, the material is automatically switched back into the blending tanks, in succession, thus insuring complete and effective blending. In this manner, even a small variation in the hour-to-hour composition of the material entering the kilns can be blended out. In actual practice and under normal operations, the mix is so closely controlled that no error in the kiln feed is discernible day after day.

The burning or calcination takes place in two Traylor rotary kilns. These are steel cylinders, 175 feet long and 11 feet in diameter, pitched ½ inch to the foot, and driven by variable-speed motors at a minimum of 1½ minutes and a maximum of 5 minutes per revolution. The kilns are lined with refractory materials. Each kiln has a capacity of 2,000 barrels of 67 per cent calcium-oxide clinker every 24 hours.

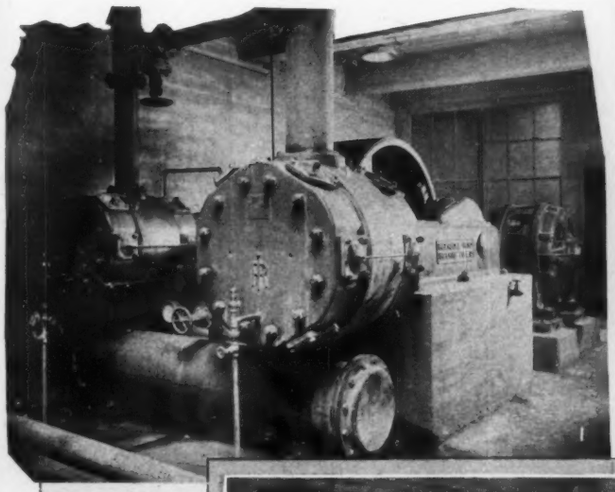
The natural-gas flame is introduced at the lower end of each kiln and is blown in with the proper amount of combustion air, which is supplied by Sturtevant fans. Gas is piped direct to the plant from the near-by Fort Collins oil field. With both kilns in service, the average daily gas consumption is approximately 4,000,000 cubic feet. The heat utilized per barrel of cement produced amounts to about 1,000,000 B.T.U's. This is considerably more economical in the use of fuel than the wet process.

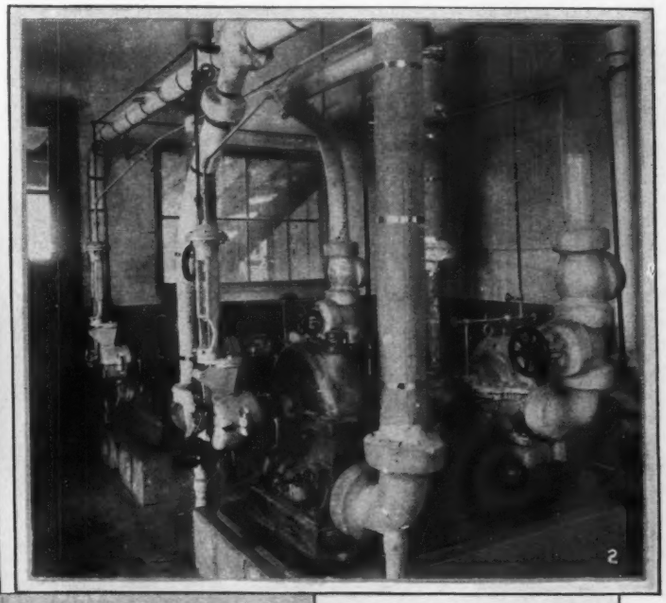
Complete equipment is installed for burning pulverized coal in case of failure of the gas supply. Coal was employed during the first two months of operation, as the gas line had then not been laid. The fuel consumption, as measured in B.T.U's, is almost the same for coal as for gas.

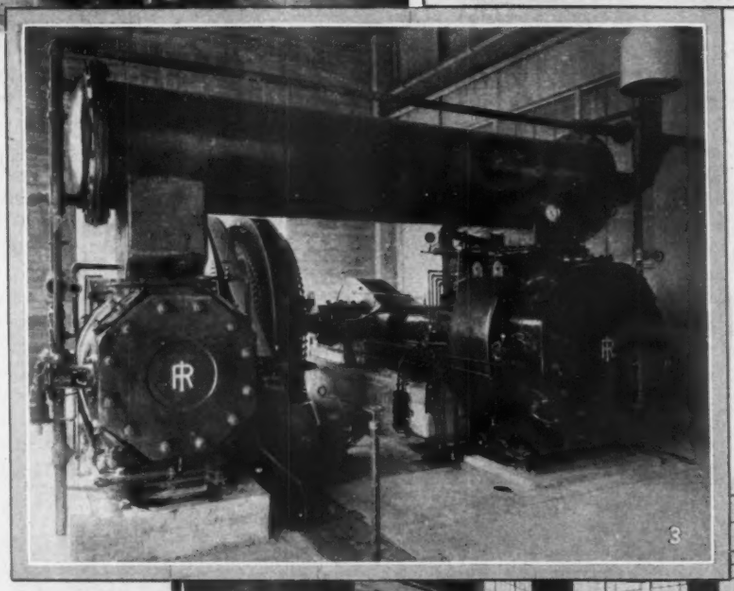
At the flame end of the kilns, the temperature is from 2,400 to 2,800° F. About two hours are required for the passage of the material through a kiln. It emerges in the form of extremely hard pellets of clinker, ranging in size up to 1 inch in diameter. This clinker drops into two Traylor cylindrical coolers, each 70 feet long, 7½ feet in diameter, and rotated by a motor. Streams of cool water play on each cooler from above. Cold air is blown into the discharge end by a Sturtevant fan. This air leaves the other end of the cooler at a temperature of from 400 to 475° F., and, as previously mentioned, furnishes the blast needed for the combustion of the gas in the kilns. Thus, advantage is taken of the heat given off by the clinker in cooling. Before entering the fans this hot air goes through a dust chamber, where the dust settles out of it. The cooled clinker can be

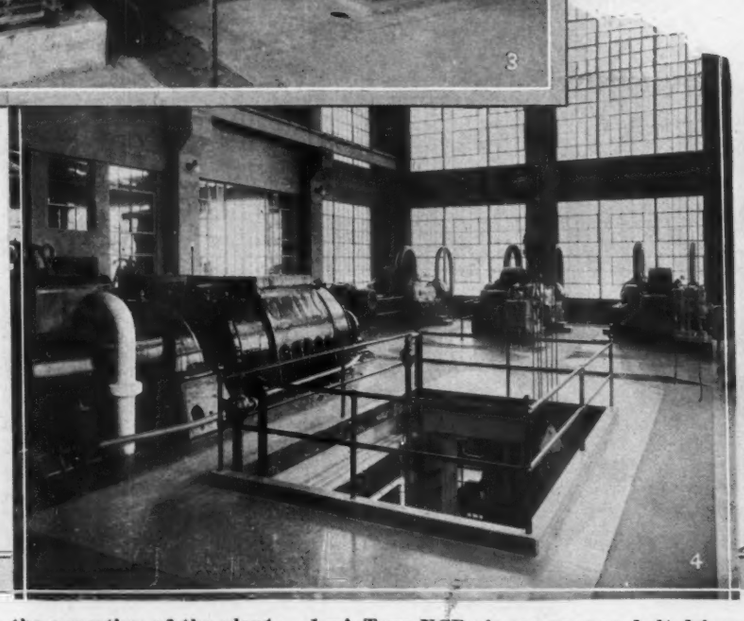


Top—Three Fuller-Kinyon air-operated pumps with their electric control panel, at the left. Left—Blowing dust and scale from boiler tubes with compressed air. Right—The chemical laboratory of the plant.





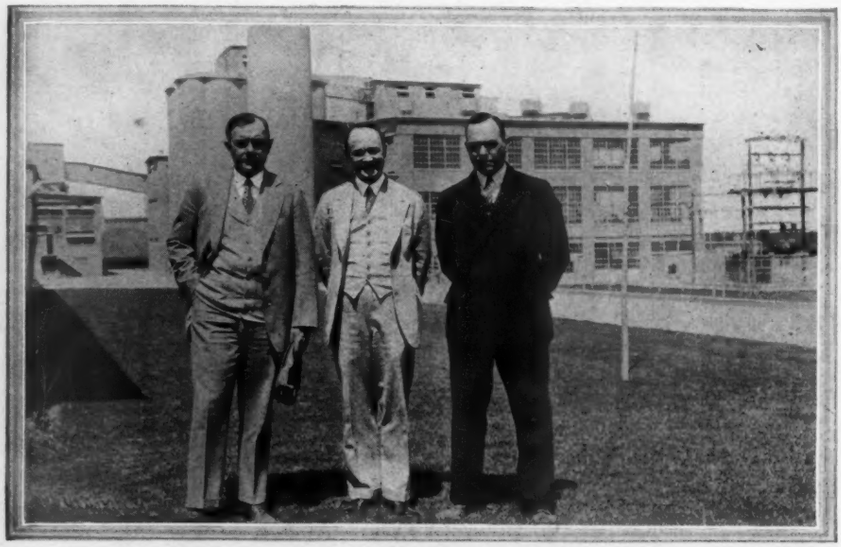




Some of the machinery essential to the operation of the plant. 1—A Type XCB air compressor, belt driven from an electric motor. 2—Two Cameron boiler feed pumps each driven by a Terry steam turbine. 3—A Class PRE-2 air compressor with synchronous-motor drive. 4—A Westinghouse steam turbine, at the left, and three Type XCB air compressors at the farther end of the room.

delivered either to storage points outside the building or, as is normally the practice, to the grinding mills. It is conveyed by belt, and passes over an automatic scale where the essential gypsum, to the amount of 2 per cent, is added by an automatic, adjustable feeder.

The product of the grinding mills is taken direct to storage silos or to the two finishing air separators already referred to. For certain uses it is desirable that extremely fine cement be available, and this is produced in the air separators. It is possible to turn out material of which 99 per cent will pass through a 200-mesh screen. It is noteworthy, and illustrative of the efficiency of the plant, that the rejects from the air separators have a fineness that is well within the Government specifications for finished cement.



The men who designed the plant and directed its construction. From left to right: J. E. Griffith, superintendent of construction; Paul C. Van Zandt, chief engineer; and J. F. Kaufman, assistant engineer.

The storage silos furnish cement to the packing plant as it is needed. Underneath the silos are two portable Fuller-Kinyon pumps traveling on rails. By means of these, material can be drawn from any one of the twelve silos, as desired. Connection is made by removing a bolted plate from the top opening and attaching the discharge pipe leading from the pump.

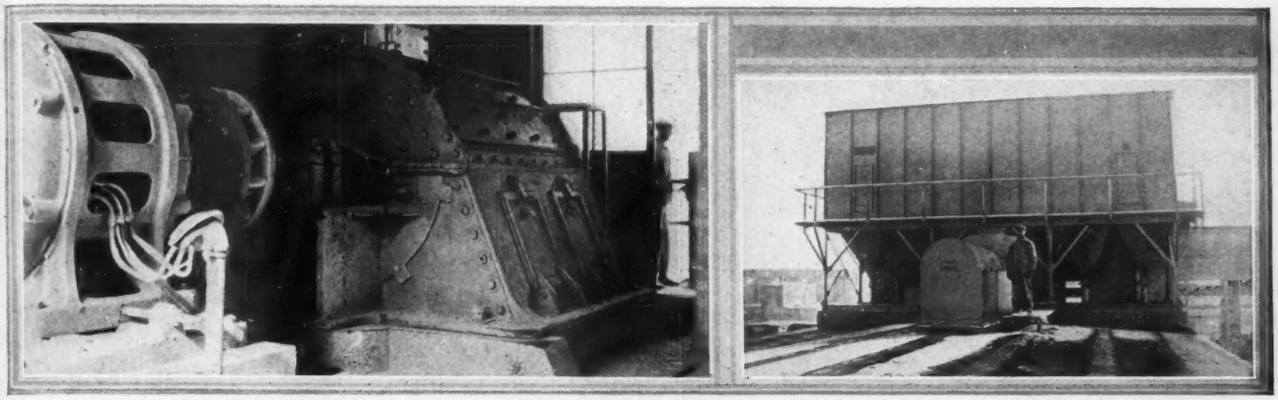
The packing plant is equipped with four packers, each having three tubes for the filling of sacks. One operator tends each packer. Railroad trackage is provided on both sides of the packing house; and two packers deliver directly to cars on each side. The packing house also contains complete facilities for handling returned sacks. These are counted on down-draft, air-swept tables, and are then conveyed to a continuous bag-cleaning machine, after which they are sorted, mended, and tied.

The utilization of waste heat for power purposes is one of the most interesting features of the plant. The waste gases from the kilns have a temperature of from 1,400 to 1,600° F. After passing into a common flue, they are drawn by induced-draft fans through two Edge Moor waste-heat boilers, each having 11,000 square feet of heating surface. The gases carry with them considerable dust, which has a tendency to cake on the boiler tubes and to reduce their efficiency. To remove this dust, workmen, stationed at either end of the boilers, insert a long pipe attached to an air hose through openings in the walls. The air blast, at 100 pounds pressure, effectively cleans the tubes. This is a continuous job for one man.

Steam is produced at 225 pounds pressure and 150° F. superheat. It is used to drive a 6,250-kv-a. Westinghouse turbo-generator. The current generated is of 3-phase, 60 cycles, and 2,300 volts. The power factor is 100 per cent. The aggregate load on the plant motors is 7,937 hp. Connection is made with the lines of the Public Service Company of Colorado through a substation, and a reciprocal agreement is in force. Power can be taken from the lines if it becomes necessary for any reason; and, in turn, any surplus current is sold to the power company. Under normal conditions the waste-heat plant provides all the electricity needed, and delivers as much as 24,000 kw-hrs. to the power company.

Water for the boilers and for general requirements is pumped from the Poudre River through a 2-mile pipe line leading to a 30,000-gallon tank on a hill above the plant. Water from the condensers is pumped to a cooling pond, discharging through 220 Binks spray nozzles. When starting up this system, the circulating pump is primed by drawing water into the suction side. This is effected by producing a vacuum by means of a compressed air ejector. The boilers are served by two

Left—Four of the five synchronous motors that drive the ball mills, at the right, in which the raw materials and the cement clinker are ground.



Left—Secondary crusher, driven by a direct-connected motor. Right—A Sly dust-collector installation.

Cameron 2½-inch, 3-stage MT boiler feed pumps.

Drinking water is supplied by two deep wells half a mile from the property, and is stored in a 30,000-gallon tank. The flow of these wells is augmented by air lifts. The air for this purpose is furnished by an Ingersoll-Rand Type 20 portable compressor of 7x6-inch size. This unit was initially purchased to drive "Jackhamers" and other pneumatic tools for drilling, riveting, etc., during the construction of the plant.

Two things impress the visitor at the Boettcher plant. One is the almost complete absence of dust, and the other is the pleasing appearance of the grounds. Because most of the machines are enclosed, and fine materials are conveyed through pipes, little dust gets into the open. Wherever there is dust, Sly dust collectors are installed. Gases, drawn through the boilers for heating, enter a Cottrell dust precipitator so that only clean gas and steam issue from the 150-foot concrete chimney. All the dust removed from the various departments of the plant is returned to the system and ultimately becomes cement.

Although little time has elapsed since the completion of the mill, attention has already been given to the aesthetic treatment of the premises. An ornamental iron gateway of great beauty greets the visitor at the entrance to the property, while the originally unsightly grounds have to a large extent been transformed into a pleasing expanse of grass and flowers. Attractive garages have been provided for employees' cars. The entire plant is constructed of concrete, and is a fitting example of the effective use of the product it turns out.

A relatively small force is required to run the mill, since machinery is utilized wherever possible. The quarry and the crushing plant work eight hours a day, while the remaining operations are on a 24-hour basis. One hundred and fifty men suffice to maintain the mill at capacity.

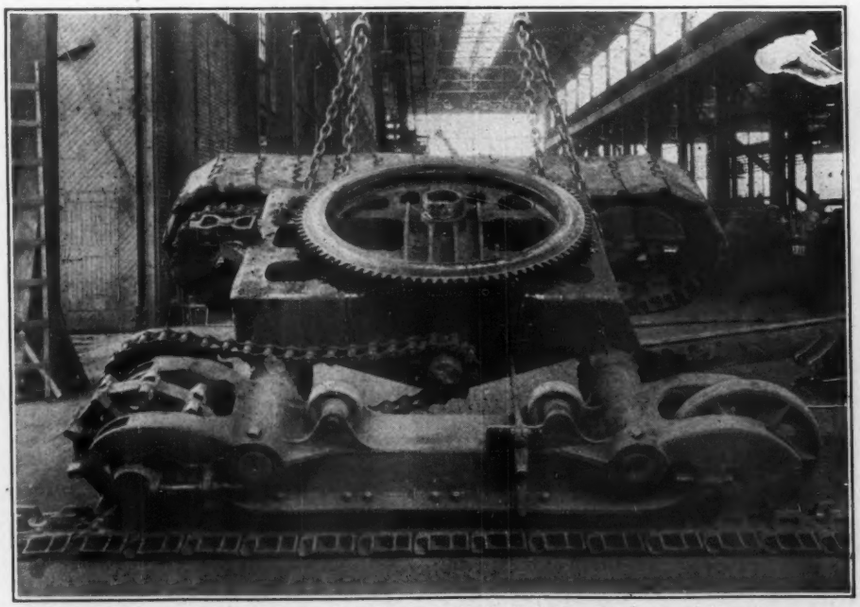
The Boettcher plant was designed by Paul C. Van Zandt, chief engineer of the Colorado Portland Cement Company. J. F. Kaufman served as his assistant, and J. E. Griffith was superintendent of construction. The operating personnel of the organization owning the new plant is made up of the following members: Charles Boettcher, president; Claude Boettcher, vice-president; R. J. Morse, vice-president and general manager; Harry James, treasurer; Harry Warner, sales manager; I. J. Dilts, superintendent; and W. G. Banks, chief chemist.

NEW CATERPILLAR MOUNT FOR POWER SHOVELS

THE accompanying photograph illustrates the new single-shaft drive, caterpillar type of mounting with which all gas-air and B-2 steam shovels manufactured by the Bucyrus-Erie Company are now equipped. Recognizing that the caterpillar mount is the most satisfactory for machinery of this kind, the company has provided a continuous-tread mounting of fewer parts—in other words, simpler in construction than the earlier models.

Expressed in the words of the maker, the single-shaft-drive mounting is non-clogging. Even when it is shoveled full of dirt it will throw out the material within its own length as it moves ahead. The one gear and its pinion are enclosed, protected against dirt and grit, and operate high above the ground. This 12-inch clearance prevents the dragging of obstacles when the shovel is traveling over rough, uneven ground.

The mounting easily takes grades of 30 per cent and steeper; and a 2-way brake allows free movement in either direction but locks the machine when digging or on a grade. It permits the making of sharp as well as gradual turns, steering from either end of the treads with the machine moving forward or backward. All wearing parts are accessible, and can be quickly and readily inspected or removed for renewal. The truck frame is a 1-piece annealed steel casting, 23 inches deep; and the treads are exceptionally strong and have 1½-inch hardened steel pins.



This 1-piece truck-frame casting is 23 inches deep, and is a fine example of a rugged and simple type of mounting.

It is now generally the practice in the Pacific Northwest to wash apples, pears, etc., to remove from the fruit harmful chemicals used to protect it from insect attack. The process consists of first passing the fruit on conveyors through sprays of dilute hydrochloric acid; then rinsing thoroughly in clear water; and, finally, drying it either with towels or with an air blast.

An Outstanding Achievement in Winter Construction

Montreal's New Stadium is Proof of What Can Be Done By Careful Planning and Modern Methods

By F. A. McLEAN

UNLIKE most large American cities, Montreal has been without professional baseball for many years or, to be exact, since it severed its connections with the International League in 1912. It was at that time illegal in that city to play games on Sunday; and for that and other reasons professional baseball could not be made to pay a profit.

The great interest in hockey, Canada's national game, and the international character of the professional contests, have developed a following beyond the fondest dreams of the original promoters of the sport in Montreal and elsewhere in America. But with the end of the hockey season in the spring, thousands of fans were left without their leisure-time diversion until the next year, and it was believed that many of them would prove just as enthusiastic over baseball played during the summer months.

With this idea in mind, the Montreal Exposition Company was organized to provide a thoroughly modern stadium where baseball or other games could be held, and which would be capable of seating comfortably larger crowds than could be accommodated in the structures then available for the purpose in the city. The contract for the work was awarded in the early part of last January to the firm of Quinlan, Robertson & Janin, Ltd., of Montreal. The completion of the huge stadium in the short space of four months is an outstanding accomplishment in building operations, and represents man's triumph over the elements. The contractor worked day and night; and concrete was sometimes poured while the thermometer hovered around 20° below zero Fahrenheit.

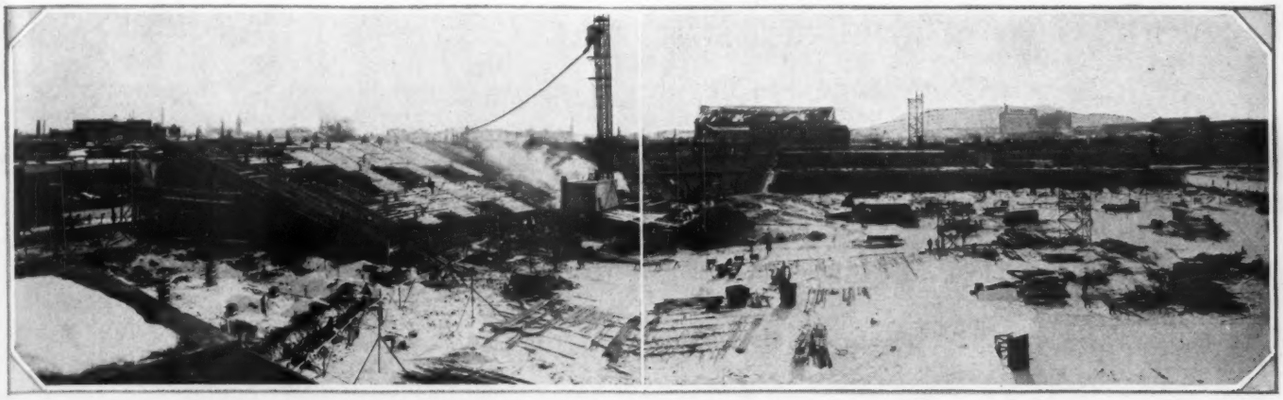
One of the portable compressors that furnished the air to operate paving breakers used to deal with frozen ground.

The Montreal Baseball and Exhibition Stadium, situated in the eastern part of the city, covers a whole block between Ontario, Delorimier, Lariviere, and Parthenais streets; and, although built under one contract, it really involved the erection of two different structures—that is, a grandstand and an exhibition building, with store space, in the form of an L. The exhibition building proper, on the Delorimier Street side, is three stories high, while the 2-story Ontario Street section houses the stores and sample rooms, thus adding considerably to the company's annual revenue. The floor area of this unit is well over 100,000 square feet.

The roof and the back walls of the exhibition building form the foundation of the second unit, the stadium, which is U-shaped. An idea of its magnitude may be obtained from the following figures. On the Delorimier Street side the grandstand extends for a distance of 528 feet; on Ontario Street, 523 feet; on Parthenais Street, 188 feet; and on the Lariviere Street side, 236 feet. The enclosed area totals more than 200,000 square feet; and the stand is capable of seating 23,000 persons. Entrance is effected by a number of gates in the exhibition building, permitting the easy handling of large crowds, while ready exit is assured by way of separate passages. The structure is fireproof throughout, being of reinforced concrete faced with red rustic brick and backed with "Duntile".

One of the conditions in the contract stipulated that the stadium was to be completed and ready for the opening baseball game,

Left—Breaking frozen ground with air-driven paving breakers equipped with moil-point steels. Right—Paving breakers loosening frozen ground so it could be shoveled by hand.



Here we see what fine progress was made in pouring concrete despite winter weather.

scheduled for May 2. A very heavy penalty was imposed upon the contractor in case of failure to meet this requirement. In less than four months, and during a season in the year when cold weather prevailed, the contractor was called upon to do the following work: To excavate 12,000 cubic yards of frozen earth for footings and walls; to grade the playing field; and to deliver and to place about 1,500,000 board feet of lumber for forms, 750 tons of steel for reinforcing concrete, 450 tons of steel for roofing, 90,000 bags of cement, 7,000-tons of sand, and 14,000 tons of crushed stone. These quantities do not include the materials needed for the exhibition building. Confronted with winter conditions, and being allowed but an exceedingly short period in which to do the work, it was imperative that the company organize and plan a schedule that could be counted upon to prevent delays as much as possible.

On January 3, operations were begun on temporary buildings for housing stores and machinery, and on suitable quarters for offices and for the convenience of timekeepers. At the same time, preliminaries necessary to locating and staking out the field were taken in hand. And let it be understood that there was then 18 inches of frost in the ground and that the snow lay a foot deep on the surface. A total of 405 footings and foundation walls—capable of withstanding a bearing pressure of 3 tons per square foot—was carried to solid ground along the entire outer face of the exhibition building.

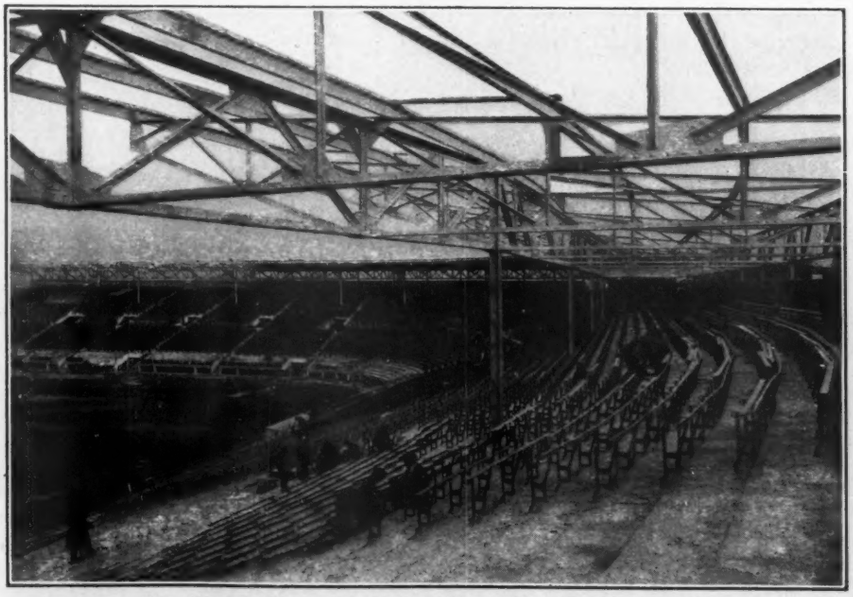
On account of the nature of the ground, which made maneuvering difficult, steam shovels could not be used to as good advantage as under ordinary circumstances. Therefore, digging was done mainly by a crew of 300 men working 24 hours a day Type CC-35 paving breakers were utilized for breaking up the frozen ground. The general rate of progress was such that 120 excavations for footings were made and filled with concrete nine days after starting the construction of the temporary buildings just referred to; and within twenty days the first columns were standing.

Overlapping shifts were organized so that operations could be carried on uninterruptedly even during meal hours. The first shift was on from 7 a.m. to 6 p.m.; the second shift from 1 p.m. to 11 p.m.; and the third from 7 p.m. to 7 a.m. On an average, a force of 700 men—including laborers, carpenters, mechanics, etc.—was employed on the job day in and day out.

On March 27, the grandstand—which, as previously mentioned, was to be finished by the beginning of May—was about four weeks ahead of schedule, while the brickwork, heating system and plumbing, millwork, electric wiring, etc., elsewhere on the project were up to schedule. In spite of such difficulties as heavy snowstorms, rain, strong winds, and extreme cold, only one day was lost during the concrete-pouring stage because of the effective use of protective tarpaulins and salamanders. This part of the contract was completed in twelve weeks. Twenty-two days before the time specified, the stadium and all its entrance gates were finished, and all the seating space was ready for the first game that was to be held on April 27, six days ahead of the date originally set.

Steam for operating the pumps and for the thawing and heating of sand, crushed stone, and water, was furnished by two 100-hp. boilers provided with suitably insulated steam and water lines. Spoils and materials were handled by two Erie shovels, an Erie crane, and two Universal cranes, equipped with orange-peel buckets. Two Canadian Ingersoll-Rand portable compressors supplied the air for the paving breakers that served effectually to break up the frozen ground preliminary to its removal.

The concrete for the stadium was mixed in a 1-cubic-yard Koehring mixer, and was delivered to a hopper, placed on the grandstand, by way of a long chute reaching back to a 135-foot tower located in the center of the field. From the hopper, which was shifted from point to point as the work progressed, the material was fed down runways and chutes and conveyed thence to the points of use by concrete buggies. A second concrete plant—consisting of a 65-foot tower elevator and a 1-cubic-yard Smith mixer—provided the concrete for the walls, columns, and floors of the western section of the exhibition building.



Erecting chairs on the seating steps of the Montreal Stadium.

The Montreal Baseball Stadium is the largest structure of its kind in Canada; and its realization has involved stupendous efforts on the part of everyone concerned in its organization, planning, and construction. The promoters have shown great initiative in carrying

A the stadium appeared early last April, shortly before its completion.

through so huge a project, which was financed entirely by private capital. Through the energy of these men, the City of Montreal has been given a stadium commensurate with its size where its sport-loving citizens can witness such games as football, baseball, and the like in comfort, and where athletic contests and other events drawing large crowds can be held.

Considering the magnitude of the project, and handicapped as they were by physical conditions, Quinlan, Robertson & Janin, Ltd.—an old-established and well-known firm in the field now known as Robertson & Janin, Ltd.—deserve much credit for bringing the work to such a successful conclusion. What they have accomplished has aroused a great deal of interest in the building industry. No small part of the success is attributable to the technical staffs of the architect and of the contracting company. These men had to do their part at nerve-racking speed in order to keep pace with the building operations. In fact, thorough organization, rigorous supervision, and a fine spirit of teamwork were responsible for this record performance in winter construction.

The stadium was built according to plans prepared by and under the supervision of John S. Archibald, who also designed the Montreal Hockey Arena and many other notable structures in Canada. Montreal may well be proud of its new stadium. That it will prove a real asset to the Metropolis is evidenced by the fact that some 24,000 people passed through its gates on the day of the opening game.

AIR-OPERATED SURGICAL INSTRUMENTS

FROM London comes the news that an assistant surgeon at Guy's Hospital, Dr. W. H. Ogilvie, has invented pneumatic instruments that will do for surgery what the air-driven chipping hammer, drill, etc., do for industry. The n w surgical instruments were on display not long ago at the London Medical Exhibition, and are designed to assist in performing operations on bones.

The claim is made by the manufacturer that the pneumatic chipping instrument, for example, has reduced the surgeon's time and labor enormously. To quote: "What used to take three-quarters of an hour to do with a hammer, exhausting the surgeon and the patient, can now be done in ten minutes."

IMPOSING OFFICE BUILDING IN ST. LOUIS

THE Missouri Pacific Railroad Company is justly proud of its new building, in St. Louis, which now houses the general and executive offices of the line. The structure, of creamy-white terra-cotta finish and pleasing architecture, occupies a plot of ground 100x192 feet on Thirteenth Street between Olive and Pine streets. It fronts upon the new municipal plaza, which is now in process of construction.

The building is of 22 stories, and rises 270 feet above the sidewalk. Provision has been made for eight more stories, which will increase its height to 395 feet and make it taller than any present skyscraper in that city. It is of steel construction, and is fireproof to such a degree that it was considered unnecessary to include a sprinkler system. The structure and the ground upon which it stands represent an investment of $2,500,000.

The weight is supported on 68 concrete foundation piers that rest on bedrock. Considerable compressed air was used in excavating for the substructure. A 10x8-inch Type 20 portable compressor furnished the air. The drilling was done with Ingersoll-Rand "Jackhamers"; and CC-35 pile drivers were employed in driving sheet piling.

Unusually rapid progress was made in the erection of the structure. Ground was broken on Thanksgiving Day, 1926. Fabrication of the steel was started March 22, 1927, and the entire building was occupied by May 1, 1928. The structural plans were designed by E. M. Tucker, architect for the Missouri Pacific, working under the direction of E. A. Hadley, chief engineer of the road.

The new Missouri Pacific Building in St. Louis, Mo. This $2,500,000 structure houses the general and executive offices of the Missouri Pacific Railroad Company.

MAKING BRICKS BY A NEW METHOD

A REVOLUTION in brick-making has been promised by two Swedish engineers who have developed what they call a dry method of manufacture. By the new process, the clay, before using, is dried at the point of production by heat or by a vacuum, and is then pulverized. The product, known as "clay metal", can be transported easily to suitably located factories, and there again turned into a plastic mass by the addition of water. Today, brick-making plants are of necessity built at the source of the raw material. After the bricks have been molded and pressed they are placed on specially constructed cars and passed slowly through a tunnel oven, where they are baked, ready for shipment.

Second Musconetcong Tunnel Nears Completion

Modern Methods and Means Used in Driving and Lining the New Tunnel Show Advances Made in Fifty Years

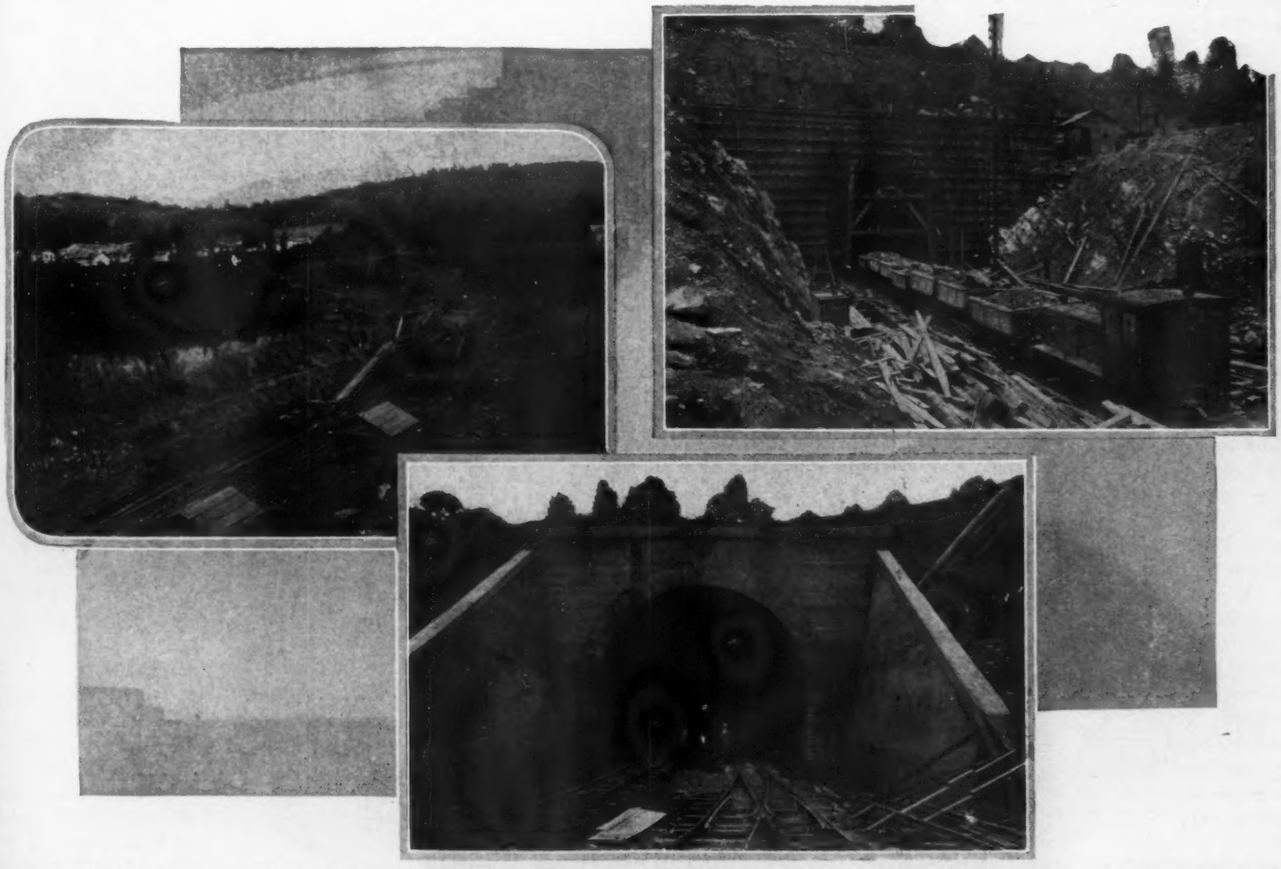
PART II

By R. G. SKERRETT

AFTER the open cut at the east end was down 70 feet at the portal site and the approach cut at the west end was down 80 feet at the portal site—power shovels and a dragline handling the dirt, then actual tunneling was started at each end by driving a 10½x11-foot crown drift; and this procedure was followed thereafter whenever the tunnel drivers had to penetrate soft or unstable ground. With the crown drift advanced sufficiently and timbered, a 6x8-foot wall-plate drift was driven first on one side and then on the other side below the crown drift; and in each wall-plate drift was placed the oak wall-plate timber that was to support the arch timbers on that side of the tunnel when the crown drift had been widened out to full size and the arch timbered. The wall plates were reinforced, top and bottom, with heavy steel I-beams. The crown bars of the arch timbers were braced by temporary posts lodged against the tunnel core; and these posts carried the arch timbers until their load was transferred to the wall plates. Finally, the load upon the arch and the wall plates was shifted to plumb posts and timber footings—the placing of these supports being made possible by an 8x10-foot plumb-post drift driven beneath each wall-plate drift.

Mucking in the crown drift and in the succeeding wall-plate and plumb-post drifts was done by hand, and the excavated material was removed in small push cars—the core section in the west end of the tunnel being afterwards mucked by an air-driven, 1½-yard Osgood caterpillar shovel. Where the tunnel has been excavated in rock, permitting the top-heading and benching method, the mucking has been done by an air-operated No. 41 Marion railroad-type shovel. On the rear end of the Marion shovel is mounted a stiff-leg derrick, carrying a straight-lift air hoist, and this derrick picks up empty cars from the track behind the shovel and spots the cars on the paralleling loading track. A "Little Tugger" hoist, mounted on the shovel, pulls the empties successively forward so that the head car can be picked up and landed on the near-by track for loading. It takes only from 20 to 30 seconds to shift a car.

In the western section of the tunnel, where the Osgood shovel is in service, a "cherry-picker", mounted on a flat car, shifts the muck cars from the empty to the loading track. The derrick on the cherry-picker is equipped with a straight-lift pneumatic hoist,



Left—West portal of the Musconetcong Tunnel and the contractor's camp near by. Right—East portal of the Musconetcong Tunnel with a train of Western muck cars on its way to the dump. Bottom—West portal of the new Musconetcong Tunnel in its completed state.

and it also carries a "Little Tugger" hoist for pulling the empty cars forward so that they can be shifted from one track to another.

In driving the old Musconetcong Tunnel, each heading required the drilling of 36 holes that had a combined footage of 408 feet. In the new tunnel, each heading in solid rock has called for the drilling of 42 holes having an aggregate footage of 474 feet. In removing the bench in the old tunnel, 10 holes were drilled, having on an average a total footage of 112 feet. The maximum number of holes on a bench in the new tunnel has been 29—more often only 25—having a combined footage of 325 feet. All blasting has been done with dynamite electrically fired and arranged for delay firing, using from naught to sixth delay.

As in the case of the old Musconetcong Tunnel, the contractor for the new tunnel equipped himself with rock drills best suited to the task in hand, which has called for expeditious work. It is, therefore, interesting to find that the headings of the new tunnel have been driven with Ingersoll-Rand R-72 drifters. The old 5-inch Ingersoll drills, used on the earlier tunnel, weighed 558 pounds each, without tripod, while the R-72 weighs but 172 pounds ready for mounting. The old drill was a piston drill that was operated at a pressure of 65 pounds: the R-72 drifter is a hammer drill working on an entirely different principle. It will operate efficiently with air at pressures of from 60 to 100 pounds; and it strikes about 7½ times as many blows a minute as did the original Ingersoll drill in service 56 years ago. The present-day drifter is also a wet drill; and because of its relatively light weight it can be shifted from position to position with comparative ease. The R-72's have been mounted on vertical columns when drilling the face and on tripods when drilling the bench in the new tunnel. Where down holes have been necessary to break away the upper corner of the bench, those holes have been drilled with "Jackhamers".

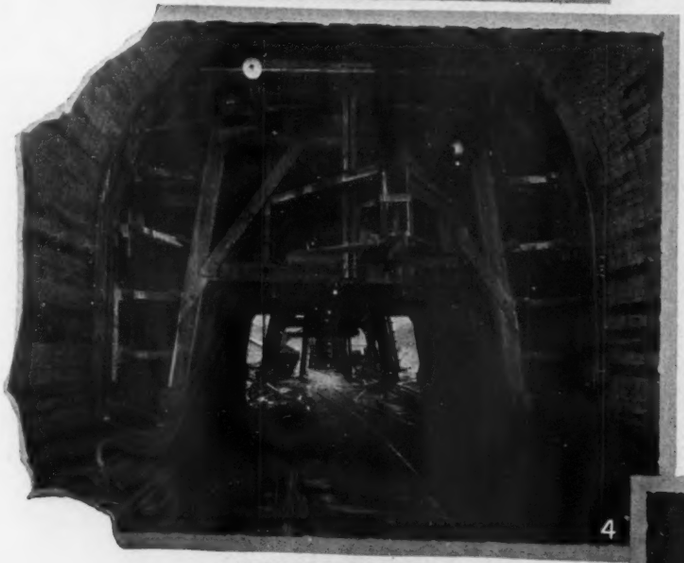
At the east end of the new tunnel, prior to striking bad ground at a point 1,300 feet in from the portal, it was found possible to advance at the rate of 50 feet a week; but when rotten and water-bearing rock was encountered progress was greatly retarded. Indeed, there were times when the daily advance did not exceed 2 feet. When the rock was hard, the R-72's drilled holes ranging from 9 feet to 13 feet in depth, while in soft rock the holes were drilled to a depth of from 6 to 8 feet. Work has been carried on continually by night and day shifts; and at the advance heading, in soft rock, each shift pulled a round and did the incidental mucking. In hard rock, it has been found possible to get a single round and to do the incidental mucking in the course of a day.

Crown bars, lagging, and timber segments in a loose-rock section.

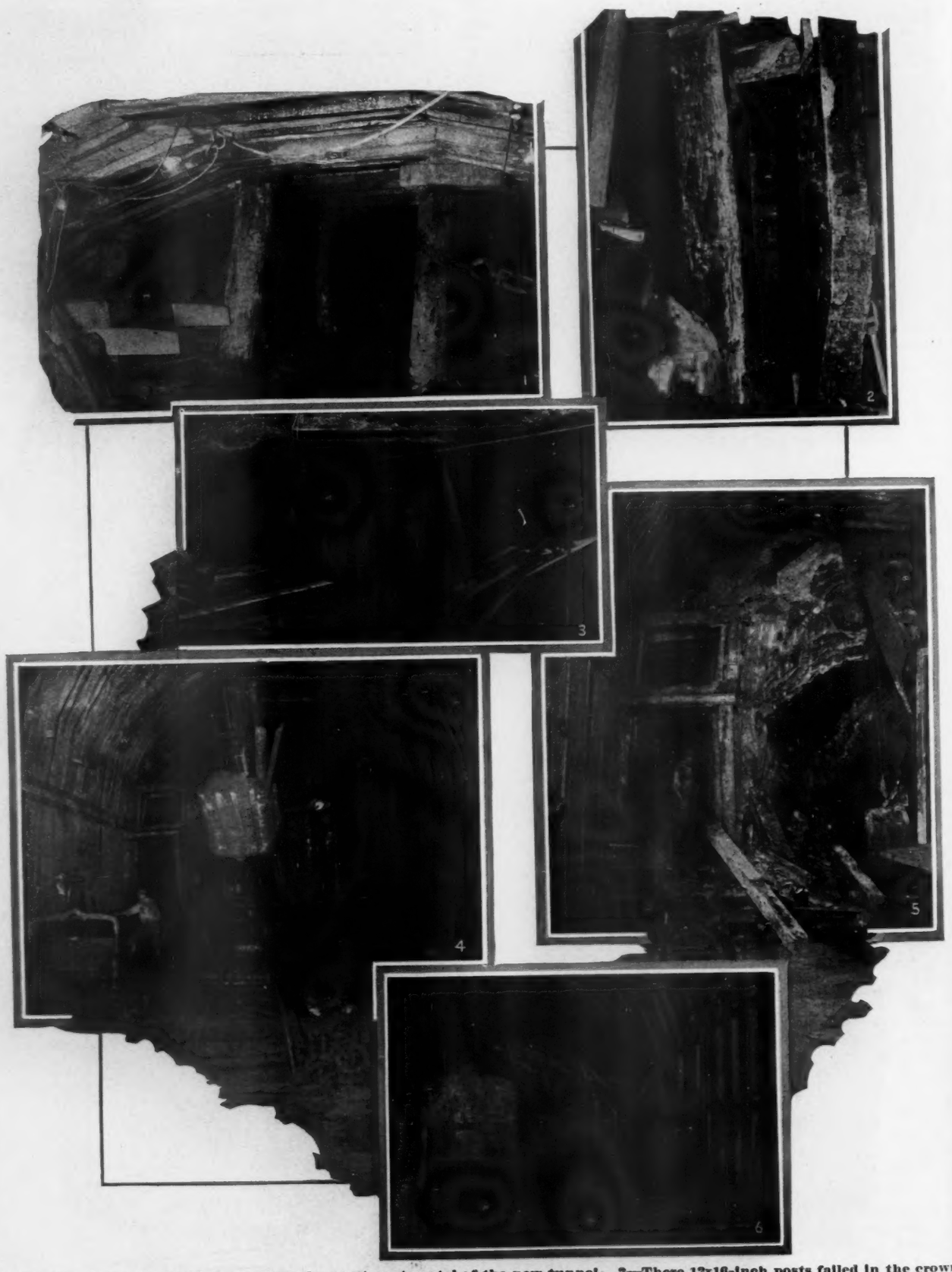
The terms hard ground and soft ground utterly fail to make plain the differences in the operating conditions. In soft ground, the tunnel drivers have had to contend with a well-nigh irresistible force that shoved the enveloping earth or rock inward despite the use of 12x16-inch fir timbers, even when very closely spaced and reinforced with steel. For instance, the yielding of the timbers showed the load to correspond exactly with the estimated breaking moment of the timbers—in other words, identical with the dead weight of nearly 500 feet of overlying ground. That is to say, the deformation of the timbers indicated a movement of the entire mass of the superposed hill! Some timbers meeting end on, were forced into each other so that their lengthwise fibers interlocked. Again, 12x16-inch stulls, placed beneath joints of timber arch segments, were split from end to end as though sheared by a titanic knife blade. In places—notwithstanding the use of 12-inch, 113-pound steel H-beams, spaced on 3-foot centers to reinforce the heavy timbers and 4 feet of concrete lining—an inward movement of 4 inches occurred before the concrete floor of the tunnel was in place. This movement indicated a pressure as high as 10,000 pounds per square foot. No wonder progress at times has been slow and the contractor obliged to proceed with the utmost caution.

Plumb-post drift near west end of the tunnel showing timber cut for placing steel lining and also some of the steel lining in position.

In lining the tunnel with concrete, wooden forms have been used; and the contractor has devised his own lining traveler. The wall sections are poured by gravity, and only the arch is placed pneumatically. The lining of the old tunnel was done by masons, and only about 1,030 feet of that structure was lined—the walls being of rubble and the arch of brick. The present method of placing the lining well illustrates the advance



1—Face of heading at east portal of the new Musconetcong Tunnel showing method of driving in solid rock. 2—Blacksmith shop at the west portal of the new Musconetcong Tunnel, equipped with a "Leyner" sharpener and an I-R oil furnace. 3—An R-72 drifter at work in enlarging the tunnel at the west portal to full size. 4—Traveler for Ransome pneumatic concrete placer used in lining the tunnel. 5—Drilling trim holes in the east portal with a "Jackhamer". 6—Tunnel section at west portal with concrete lining in place and forms for lining in position.



1—Stulling under timber lining on top of core at west portal of the new tunnel. 2—These 12x16-inch posts failed in the crown heading in soft ground because of the tremendous pressures developed. 3—Enlargement timbering at west portal. Note crown bars, lagging, and collar braces. 4—Face of core at west portal where the five drifts can be seen. 5—Left half of core face at west portal, showing crown drift, wall-plate drift, and plumb-post drift. 6—Tunnel section at west portal with steel supports in position.

made in utilizing mechanical means where formerly the work was done slowly and by hand.

Compressed air was used in the old Musconetcong Tunnel to drive only rock drills, while in the new tunnel it is employed for numerous purposes—some of them already mentioned. Compressed air is utilized by the oil furnaces, the pedestal grinders, and the "Leyner" drill-steel sharpeners in the blacksmith shops. In the old tunnel, all drill steels were sharpened by hand, and probably were not then sharpened until they had become too dull to work properly. Each of the blacksmith shops on the present job has handled as many as 350 to 400 pieces of drill steel daily; and Ingersoll-Rand Swedish drill steel has been used. Thus, the drill runner has been continually supplied with uniformly shaped, well-sharpened bits made of superior steel. The drills, themselves, have been regularly withdrawn from the headings at the end of each shift and turned over to the drill doctors for inspection, cleaning, and lubricating. This has contributed much to the splendid performances of these rock drills, and, in part, explains the exceptionally low upkeep cost.

Cooling water for the heat treatment of the drill steels is kept at a constant temperature in each blacksmith shop by circulating water delivered there by an air-driven GSS Type Cameron pump. At each end of the tunnel a Cameron pump supplies cooling water to the compressors and to the rock drills at work. Air-driven Cameron pumps have handled all water seeping in at the headings. The gradient of the tunnel is about 0.2 per cent—the summit of the grade being in the center of the tunnel, thus making it self-draining toward the portals. Compressed air is furnished by four motor-driven compressors each having a piston displacement of 1,000 cubic feet a minute. Air is delivered to the working places at 80 pounds pressure through two 4½-inch lines that come together at a single 5-inch line—this arrangement providing for operating flexibility.

The tunnel has been ventilated by two 4,000-cubic-foot motor-driven Roots blowers —one at each end of the job—that distribute the air through 18-inch metal piping except near the headings where a collapsible, rubber-treated-fabric conduit is in use. The fabric conduit, known as "Ventube", is less susceptible to injury when exposed to flying rock

When completed, the tunnel will contain close to 50,000 cubic yards of concrete, 3,000,000 board-feet of timber, and substantially 1,700 tons of reinforcing steel—enough steel to load 50 cars.

A maximum of 500 men has been employed in driving the new Musconetcong Tunnel. The men have been accommodated in two camps, one at each end of the tunnel, and each camp is capable of housing comfortably 250 workers. These camps are provided with cold and hot water, electric lights, a first-rate commissary, and other conveniences. In many ways, the camps are of a distinctly superior sort; and, to add to the pleasure

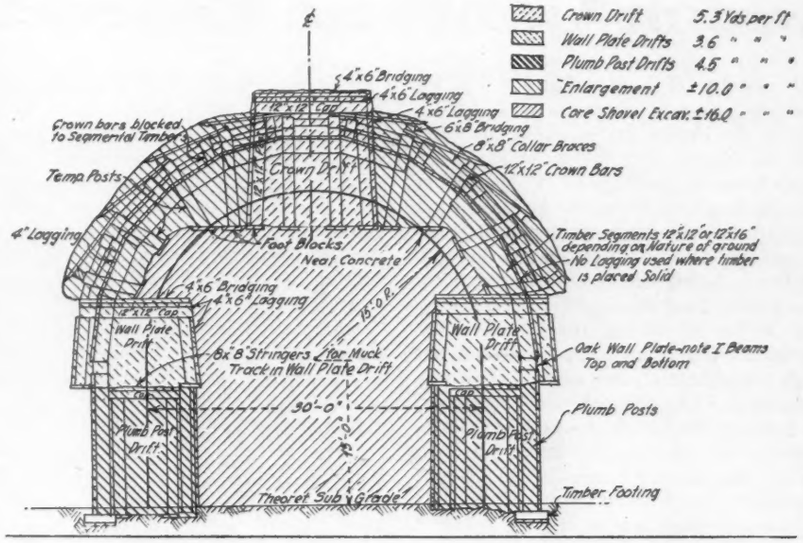

Crown Drift 5.3 Yds per ft
Wall Plate Drifts 3.6 " " "
Plumb Post Drifts 4.5 " " "
Enlargement ±10.0 " " "
Core Shovel Excav. ±16.0 " " "
4"x6" Bridging
4"x6" Logging
6"x8" Bridging
8"x8" Collar Braces
12"x12" Crown Bars
Crown bars blocked to Segmental Timbers
Temp Posts
Crown Drift
4" Logging
Foot Blocks
Neat Concrete
Timber Segments 12"x12" or 12"x16" depending on Nature of ground
No Logging used where timber is placed Solid
15'-0"
Wall Plate Drift
6"x8" Stringers for Muck Track in Wall Plate Drift
Oak Wall Plate-note I Beams Top and Bottom
30'-0"
Plumb Posts
Plumb Post Drift
Theoret Sub Grade
Timber Footing

Diagram illustrating method of driving the new tunnel in soft or heavy ground.

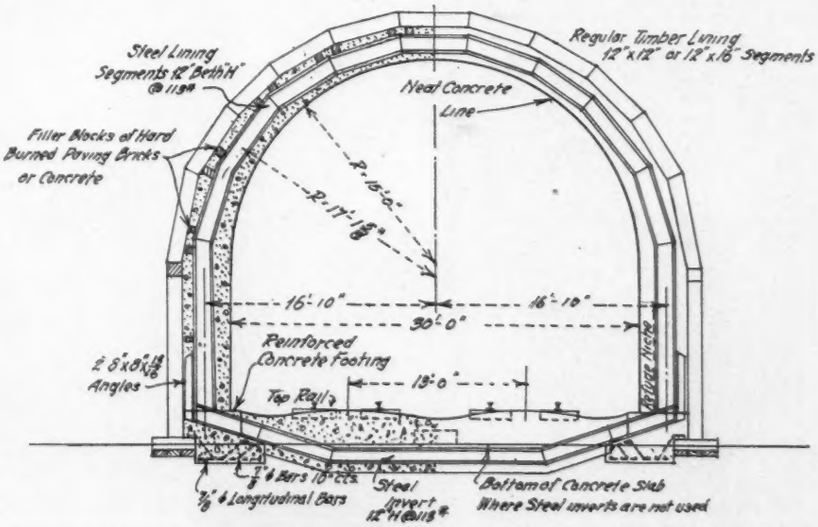
of the men, the reading room in each camp is equipped with a radio and a Victrola. In brief, the present camps are palatial compared with the quarters provided for the men that helped to build the old Musconetcong Tunnel.

The new tunnel was holed through on June 19, the west heading then being 1,700 feet in from the west portal and the east heading 3,200 feet in from the east portal—the lesser distance of the west heading plainly indicating the difficult nature of the ground through which that section of the tunnel was driven. Shortly after holing through, a stretch of blocky rock began an inward movement that has caused the deformation of some of the timbering; and this situation will probably delay the opening of the tunnel about a month.

One of the conditions of the contract stipulated that there should be no blasting when trains were within the block at either end of the old tunnel. On an average, there is a train moving east or west every 22 minutes in the course of 24 hours; but despite this handicap the contractor has so regulated his operations that never once has he interfered in the least with the railroad's maintenance of its scheduled service. This is certainly a fine performance.

On behalf of the railroad, the work has been carried on under the general supervision of G. T. Hand, chief engineer, and W. H. Ramsey, resident engineer. The contractor has been represented by Roy E. Ross, district manager for the Bates & Rogers Construction Company, of Chicago, Ill., with William Fowler, as superintendent.

It has been recognized for some time past, says *Tin*, that the lead casing used for cables is unsatisfactory. After experiments covering a period of five years, in an effort to find a solution of the problem, the British Admiralty has recently issued a tentative specification calling for a tin content of 3 per cent.



Cross section of finished tunnel where timbered, lined with steel, and then faced with concrete.

Green Concrete Cured by New Process

THE mileage of hard-surfaced roads, especially those of concrete, is increasing yearly in the United States where the automobile is sharing with the railroad in the transportation of passengers. As most of us know, modern construction methods have greatly speeded up the work of building concrete roads; and now we learn that the interval between the laying of the concrete highway and its use by the public has been lessened by a new method of curing the plastic mass. This method, known as the Hunt process, has been developed after years of experimenting, and is now extensively employed in the West. In fact, within the past year, about 10,000,000 square feet of concrete pavement has been cured by this process in southern California alone.

It is an accepted fact among the initiated that there is sufficient moisture in newly laid concrete to effect a cure provided, of course, the evaporation of that moisture can be effectually retarded. This is the underlying principle of the Hunt process, which consists in spraying the surface of the green concrete, immediately after it has been poured and belted, with a composition especially prepared for the purpose. "McEverlast Paving Special", for so it is called, is composed principally of Trinidad Lake asphalt and gilsonite, another variety of asphalt, which are blended at an extremely high temperature.

The equipment used for the work comprises a 5-hp. gasoline engine driving a compressor having a capacity of 18 cubic feet of free air per minute and capable of maintaining a maximum pressure of 125 pounds per square inch; a long-handled spray gun equipped with a Bean nozzle; and a 12-gallon pressure container to which are attached two lines of hose, one leading to the compressor and the other to the spray gun. The coating, which is applied cold, is said to dry very quickly and to form so effectual a seal that sufficient moisture is retained in the mass to uniformly cure it from the surface through to subgrade.

According to H. T. Brewster, engineer of materials and tests of the Texas Highway Department, "A half-mile stretch of pavement, near Laredo, was cured by the Hunt process to determine its relative merits as compared with ponding or the use of moist earth. The pavement in this section was subject to severe weather conditions: the temperature was very high in the daytime, with prevailing hot and dry winds, and the nights were cool. Under ordinary circumstances, this caused checking during the day; and some cracks appeared in the concrete owing to temperature changes. It was found after the first day's curing by the Hunt process that checking was prevented.

"The material is applied very much as paint is sprayed on an automobile by the modern air brush. The process has sometimes been referred to by men that have seen it as the "Duco" finish for highways. After the concrete has become hard, the coating is found to be an integral part of it, and cannot be removed. However, while the pavement is still wet, the coating can be lifted in a thin sheet.

"There are a number of reasons for using this type of curing, both from the viewpoint of the contractor and the engineer. In the first place, it is not necessary to disturb the shoulders to get cover material; it assures a uniform cure; the contractor does not have to provide canvas or burlap, nor is water required to keep the concrete wet; the pavement does not have to be cleaned at the end of the curing period; and, from the preliminary tests made, it seems that roads so treated can be opened to traffic much sooner than is the case otherwise." Since the report was published from which these extracts were taken, the Texas Highway Department has cured three large Federal and State Aid projects by this improved method.

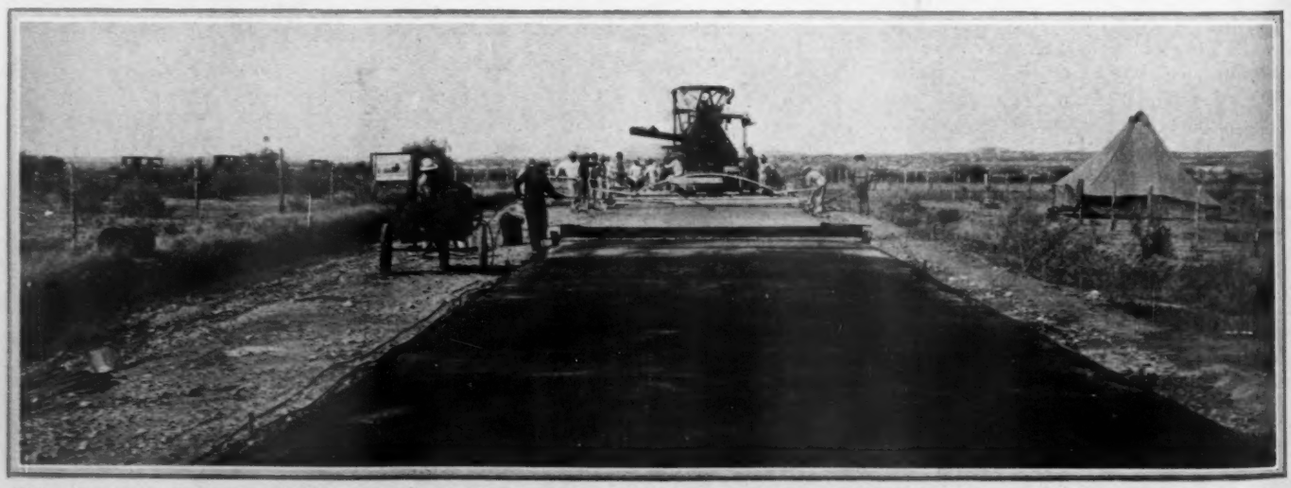
The use of the Hunt process, however, is not confined entirely to the curing of pavements. Concrete septic tanks, reservoirs, walls, piping, piling, etc., may in this manner be given a coating highly resistant to sewer gas, acids, alkali, and salt water.

NEW BOOT PROTECTS MINER'S TOES

THE Anaconda Copper Mining Company is responsible for the introduction of a rubber boot for miners, working under wet conditions, that promises measurably to lessen toe accidents which, it has been found upon investigation, result in much loss of time. In fact, of all accidents in the company's mines that caused the loss of more than 14 days' time, one-fourth was attributable to mashed or broken toes. It was not desirable to discard the more durable and watertight rubber boot for the stouter leather boot, so a rubber manufacturer was asked to make a toe cap that would afford greater protection.

According to the *Anode*, steel toe inserts were first tried and were only partly satisfactory. Hard-rubber toe caps broke under impact. Finally a semi-hard rubber compound was produced capable of withstanding the tests imposed, and this was accepted for use in the new type of boot. A pressure of 800 pounds is required to depress the cap so as to cause pain to the wearer. On release of the weight, the cap resumes nearly its original form. Impact tests were also made, and the toe cap was found to resist a blow of 270 pounds to the square inch before becoming sufficiently compressed to pinch the foot—the flexibility of the cap then being ample enough to restore it to its normal shape.

The name gunite has been given to a new graphitic steel which has been produced after a long period of research by the Gunite Corporation, Rockford, Ill. It is a high-carbon steel with graphitic carbon distributed uniformly by a precipitation process; and is said to be characterized by great strength, toughness, rigidity, and resistance to wear. It has already found numerous uses in the automobile industry.



Bituminous coating sprayed with compressed air on wet concrete to prevent the formation of cracks, due to temperature changes, in the surfaces of newly finished highways.

Refrigeration Essential in Manufacture Of High-Grade Candies

By WILLIAM J. McCLOSKEY

THE United States is the greatest candy-producing and candy-consuming country in the world. Candy's share of the consumer's dollar, according to the Census of Manufactures for 1925, amounted to $378,081,441, or 3.6 per cent of the total food group.

How many of us that enjoy eating candy realize that the ingredients that are used in making it reach us from the four corners of the earth? For example, almonds come from the sunny gardens of Spain, Italy, and France; pistachio nuts from Turkey: pine nuts from Sicily; and dates from Egypt and Arabia. The next time you are enjoying the flavor of a date center, remember that the date was probably carried on camel back, over a part of the greatest desert in the world, to a seaport for shipment to this country where, in a modern factory. it is transformed into the titbit that so delights your taste.

It is hard to form a mental picture of the gigantic enterprise that is back of a box of candy, particularly when we stop to think that the importation of the necessary foodstuffs is not the only problem, because the best of engineering skill is required to produce a box of assorted chocolates.

The firm of Henry Maillard, Inc., of New York City, manufactures cocoa, chocolate, confectionery, glace fruits, ice cream, pastry, and numerous other products. Their plant in Long Island City is a splendid example of the part that engineering efficiency and scientific care play in the manufacture of really fine candy in large quantities.

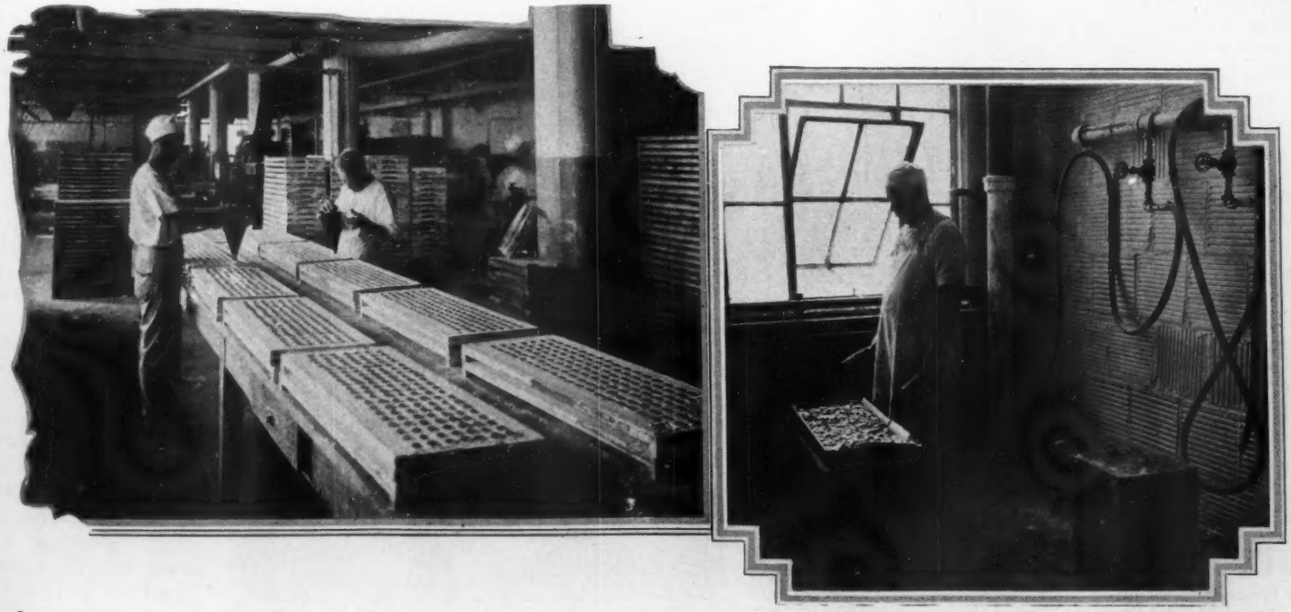
Let us see just how candy is made in order that we may be better able to appreciate how essential refrigeration, air-conditioning, heating machinery. and the best boiler-room practice are to the candy industry.

THE consumption of candy in the United States has reached 11.84 pounds per capita, and seems to be increasing. In some states, however, the average demand is much higher than in others. Nevada, for example, comes first, with a per capita consumption of 17.44 pounds, while South Carolina is lowest in the list with a total of only 4.61 pounds per person. New York leads all the states in the manufacture of candy, having a normal production-rating of $100,000,000 a year.

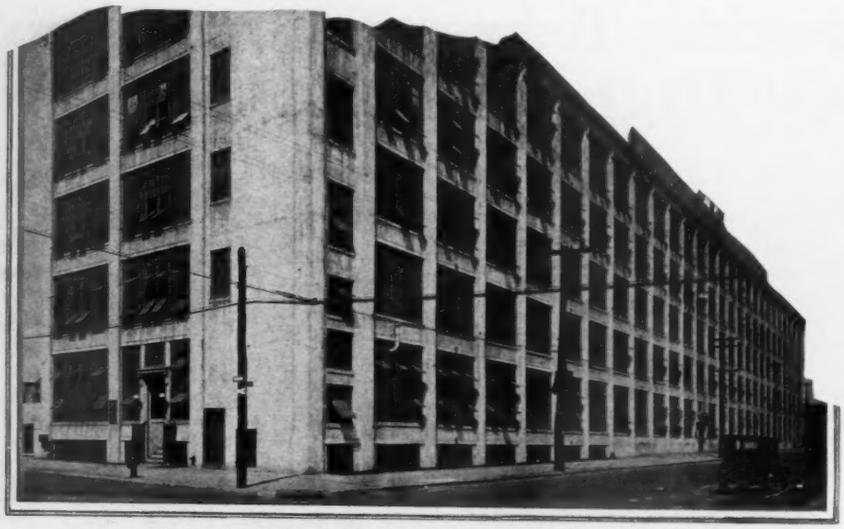
The tremendous demand in this country for good candy has placed the industry, as a whole, on a sound basis. Today the making of really fine candy in quantity depends on the best boiler-room practice, on the most modern refrigerating and heating machinery, and on engineering efficiency of the highest order. It would be impossible, as this article makes plain, to manufacture quality candy on a large scale under other conditions.

The centers of chocolate-covered bonbons are made from what candy manufacturers call a sugar cream This mixture is heated to a certain temperature and then churned to a white, snowy paste. This paste is next poured into cornstarch molds, where it remains overnight to harden. The following day the centers are removed from the molds and taken to the cleaning room, where they are freed of starch by the use of compressed air and a brush. Now the centers are ready to be dipped or covered with chocolate. Some of them are dipped by hand while others are coated by machine. The machines are capable of dipping hundreds of centers a minute. The centers are placed on a belt in rows. This belt passes them through the machine that covers them with chocolate—any excess chocolate being blown off with compressed air. The candies then are picked up by a belt, on the other side of the machine, and travel through a cold room. By the time they reach the end of this belt they are ready to be packed.

It is in the dipping room that air-conditioning and temperature play an important part in the daily production of good candy. The chocolate coating must be dried quickly, or it will remain soft and turn gray, and the candy will be spoiled. The temperature of this room is always maintained between 64 to 66° F., and the relative humidity at 50 per cent.



Left—Pouring candy centers into starch molds where they are left overnight to harden. Right—Removing starch from the molded candy centers with a blast of compressed air and a brush.



Home of the Henry Maillard, Inc., Long Island City, N. Y.

Nougat and similar candies are made from the whites of eggs and honey. This batter is beaten to a white foam, and to it are added the desired nuts and flavorings. The mixture is placed on wooden trays, covered with wafer paper, and allowed to harden. It is then cut to size by circular knives set in a powerful machine, called a nougat cutter. Nougat is a very delicate candy, and is extremely susceptible to changes in temperature. The temperature of the room in which nougat is prepared must be kept at 70° F., and the relative humidity at 50 per cent.

Maillard hard candies are made in the good old-fashioned way by cooking over an open fire. The writer is told that no other system of cooking imparts the delicious toasted flavor to the sugar. After cooking, these candies are formed by pouring the syrup into molds, where they are permitted to harden. Hard candies are also very susceptible to changes in temperature; but, unlike nougat, they must be handled in a cold room. In their case, humidity plays a greater part than temperature. The relative humidity of the cold room must always be near 40 per cent, otherwise the candies would be spoiled in handling and packing.

In the packing room there are large, continuous belt conveyors on which travel the boxes that are to be packed. Girls are stationed at the sides of these belts; and, as the boxes pass by, they place in them two or three assortments of the candies they are to contain. By the time a box reaches the end of the belt, or its starting point, it is full. The air in this room must always be in perfect condition, or the candies would become soft, and then it would be impossible to handle them without damaging them.

In the shipping room candies are stored throughout the year to meet the demands of the seasons. The Christmas demand is the greatest of all; and candy manufacturers must start weeks ahead of time so as to be able to supply the Yuletide market. Candies are also kept in storage to allow them to mellow. The soft centers, for example, are hard when they are dipped. Only time will cause the inversion of the sugar mixture from a solid to a soft or liquid form, as the case may be. The temperature and the air conditions of the storeroom are factors of paramount importance, and must be carefully watched. Failure to do this might cause the huge stock of candy held there for ageing and shipping to be ruined.

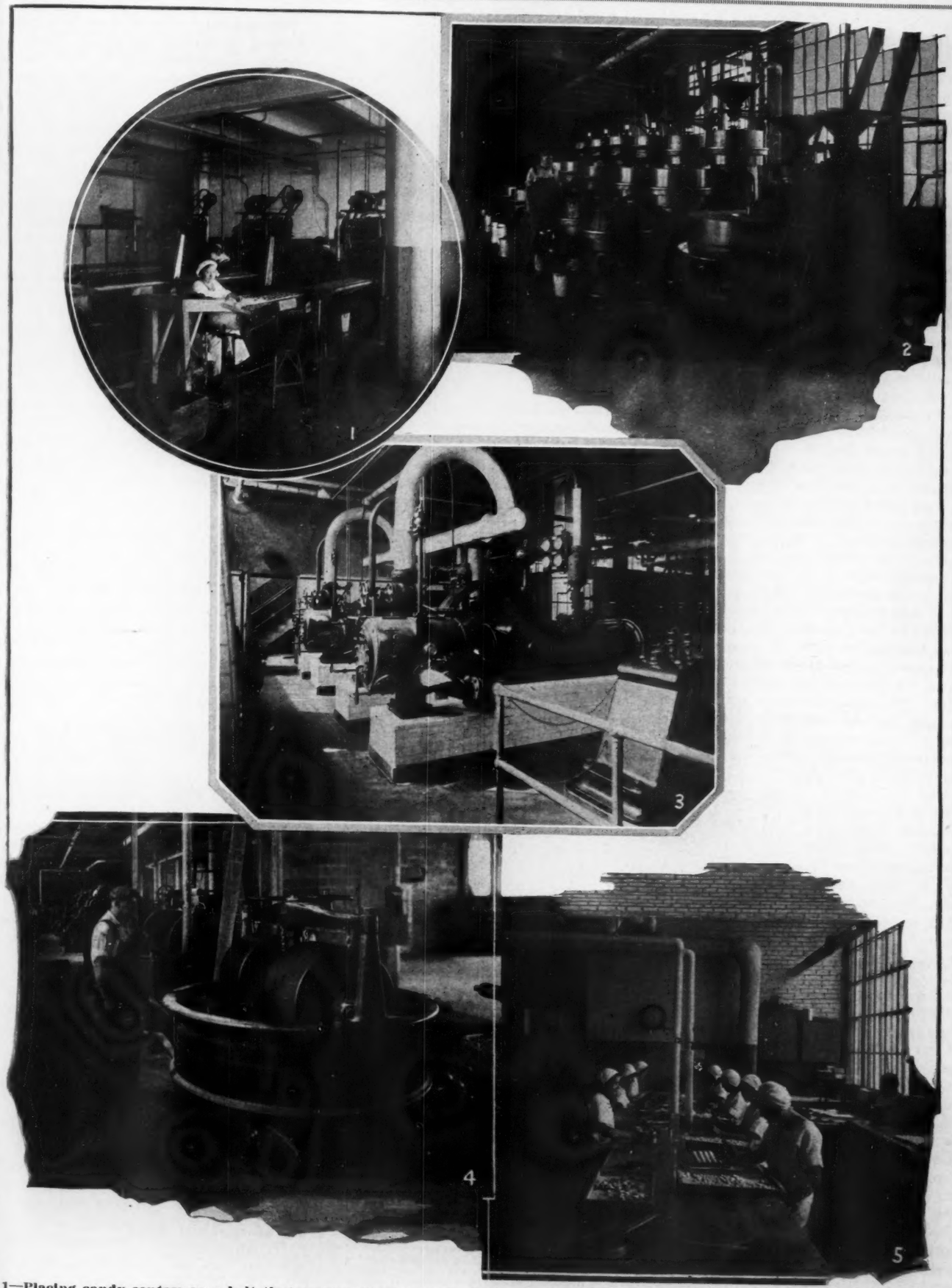
From the foregoing one can readily see that the problems of refrigeration and air-conditioning in a candy factory are many and varied. Some idea of the magnitude of the task, in this particular case, was gained when it was brought to our attention that one floor of 5,000 square feet is maintained at a temperature of 45° F. all year, while the temperature in another department must be maintained at 40° F. These rooms are used for chilling and hardening the chocolate.

The work of refrigerating and air-conditioning the plant of Henry Maillard, Inc., is accomplished by two 2-stage, steam-driven Ingersoll-Rand ammonia compressors each having a capacity of 100 tons. Two dehumidifying machines cool large quantities of water by pumping it over ammonia coils. The air is then washed by being forced through cold-water sprays in the machines; and finally delivered to all parts of the building through air ducts. When the air is released, it is dehumidified by expansion.

An automatic thermostatic control assures the release of the air, at the proper temperature, into the different rooms. If the air goes below the desired temperature, steam radiators in the air ducts are automatically turned on and the flow of cold air in the ducts thus decreased until the desired temperature is attained. In addition to serving the dehumidifiers for air-conditioning, the two ammonia compressors supply refrigeration for the 5 000 square feet of floor space that is maintained at a temperature of 45° F., and for an ice box on the third floor. The compressors have been in operation for two years now; and chief engineer Hugh McCann says that they have given perfect service and have not cost a penny for repairs.

Packing room, showing continuous belts on which the boxes travel while being filled with candy.

The engine room of this plant is complete; and all the power for motors, and for heat and light is generated there. Steam is used as a prime mover. Three Edgemoor water-tube boilers furnish steam for the ammonia compressors and for the two Rice-Sargent engines, direct connected to Crocker-Wheeler generators, which supply power and light to all the machinery. Steam is also utilized for cooking. The engineer and his force keep a careful record of production costs. Every pound of coal used, every pound of ashes removed, and every pound of water going into the boilers is listed. A dial record of the temperature of the feed water passing to



1—Placing candy centers on a belt that conveys them to a dipping machine, on the right, which dips hundreds of chocolates an hour. 2—These cocoa-grinding mills convert the toasted cocoa beans into a liquid. 3—Two 14-inch-stroke, Type XPV-3A ammonia compressors in the engine room of the plant of Henry Maillard, Inc. 4—Mixing chocolate before it is cast into cakes. 5—Hand-dipping sugar-coated bonbons.

and from the pumps is closely noticed. In this way the chief engineer is able to obtain accurate cost figures.

When Henry Maillard, Sr., left the Royal House of Louis Philippe in 1848 to come to America with his cooking kettle, he had one aim, and that was to produce quality candy. In all probability he never even dreamed that the firm that bears his name would be turning out candy, equal if not superior in quality to his, at the rate of many tons a day. Science and engineering skill have made this possible.

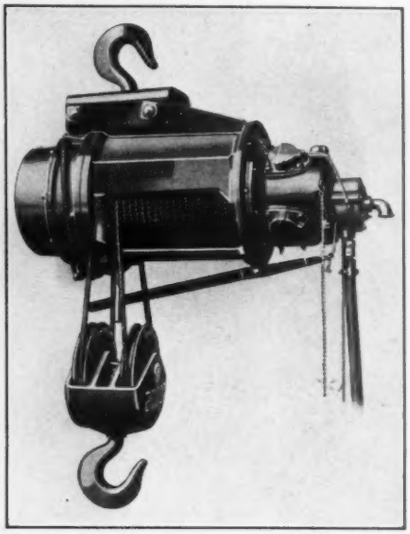
POWERFUL AIR-MOTOR HOIST CAN LIFT TEN TONS

THE Ingersoll-Rand Company has announced that it is prepared to deliver an air-motor hoist of a new size with a lifting capacity up to 10 tons. This is the largest and the most powerful pneumatic hoist yet built by this company; and it is well adapted for use in railroad shops, for example, in handling locomotive drivers at lathes and presses and in doing other heavy work that would ordinarily require a crane.

The air motor is of the 4-cylinder type and geared to a rope drum, the entire construction being enclosed in a compact and dirtproof housing. The gears are made of a special heat-treated steel so as to insure added strength and durability. They operate in a bath of semi-fluid grease that is also protected from dirt by being encased. Ball bearings or bronze bushings are provided wherever, from past experience, they can be counted upon to increase the hoist's efficiency and to lengthen its life. The motor cylinders are not only renewable but also interchangeable, making it, so it is said, an easy as well as an inexpensive matter to replace them after they have become worn through service.

The new hoist, like the earlier models, has a safety brake that automatically holds the load at any desired point and for any length of time regardless of air pressure. Instant and complete control of the hoist movement is obtained by means of a graduated throttle and by reason of the fact that the motor is well balanced—running virtually without vibration, so it is claimed.

This Size G hoist, as it is designated, has a maximum lift of 16 feet. Equipped with a top hook, the hoist weighs 1,300 pounds: with a chain-driven trolley its weight comes to 1,800 pounds. Either one or the other, of standard make, can be furnished. If necessary, however, the company is ready to build special trolleys to meet customers' requirements.



The new Size G air-motor hoist which has a maximum lifting capacity of 20,000 pounds.

HATS FOR MINERS

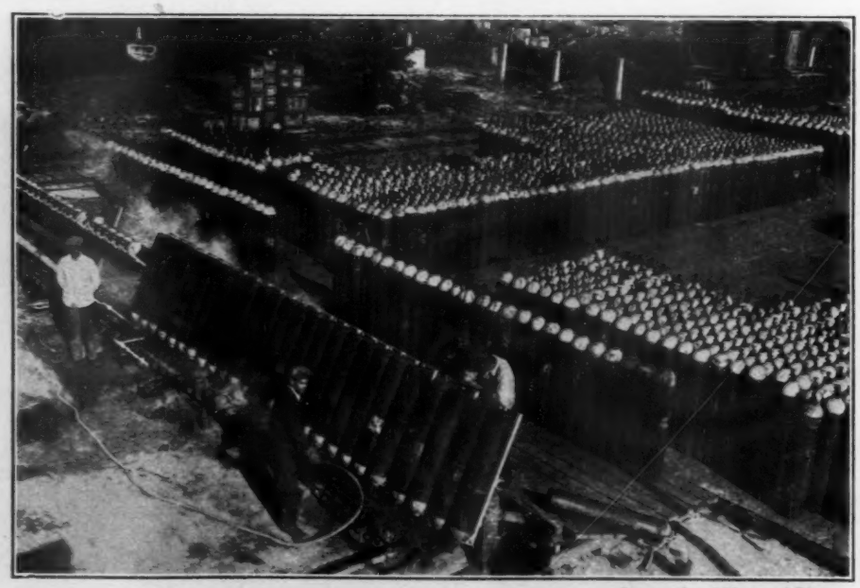
"SPEAKING of accidents," said the plant superintendent, "I have always taken the position that an ounce of protection is worth a good deal more than a pound of cure. Just as long as we are dealing with human beings in our business we can never prevent all accidents. Unfortunately, we all slip at times, so I say that what you can't prevent you can, perhaps, protect."

"That's true," answered the mine manager, "and to illustrate how we have made a practical application of your theory of protection, here's one example. Most of our operations are underground; and it was always a problem with us to safeguard our men from the ordinary hazards of falling rock, low roof, exposed wires, and that sort of thing. Yes, we had installed the most modern methods; but, despite that, every now and then a man would go down with a cracked skull or similar injury. That, in itself, was bad enough; but it involved, besides, lost time—a link out of our production chain, compensation, etc. And worst of all, there was the bad effect on our men's morale.

"Well, one day we read about the hard-boiled hat in a Bureau of Mines' circular. Apparently, it had a splendid record in accident prevention. It is a comfortable, lightweight affair that is strong enough to withstand the blow delivered by a 1-pound rock dropping from a height of from 6 to 8 feet. We looked into the matter, and decided to give the hat a trial.

"This headgear has worked out very well; and where we have not been able to prevent rock from falling we have been able, because of it, to protect men so exposed. During the past two years, in which there would otherwise have been several fatalities and dozens of injuries from head accidents, no deaths have been recorded and the number of men injured in this fashion has been markedly reduced. We have one man now who is temporarily laid up with a sprained neck: a 4x4-inch caught the side of his hat. Without the head covering, this would undoubtedly have been a case for the coroner."

"You've given me an idea that might be used to advantage in our business," replied the plant superintendent. "Why can't we get something similar for those of our workers who toil beneath overhead cranes?" "Well, retorted the mine manager, "if, like ourselves, you can't altogether prevent head accidents, you can protect your men against them by making them wear hard-boiled hats."



International Newsreel Photo.

Just before the "Graf Zeppelin" left our shores on her eastward flight across the Atlantic, her fuel tanks were filled with 21,000 cubic meters of what is known as "blau gas", named after the German chemist who introduced it commercially about twenty years ago. In this picture we see the liquefied gas being vaporized before going aboard the giant airship. Apart from its availability as a motor fuel, blau gas is admirably suited for use in airships because it simplifies the problem of compensating for loss of weight due to expended fuel. That is to say, the weight of the gas is about that of atmospheric air, and the space occupied by the gas before use can be replaced by an equivalent volume and weight of free air.

Operations have been started on a $40,000,000 power project on the Connecticut River at Monroe and Littleton, N. H., and Barnet and Waterford, Vt., that is expected to give employment to 4,000 men for three years. Upon completion, the dams will create lakes holding more than 7,000,000,000 cubic feet of water; and a total of 250,000 hp. will be developed.

Blowing Beverage Bottles By Machine

New Plant of F. E. Reed Glass Company, Rochester, N. Y., Is Built to Produce 110,000 Bottles Every 24 Hours

By S. G. ROBERTS

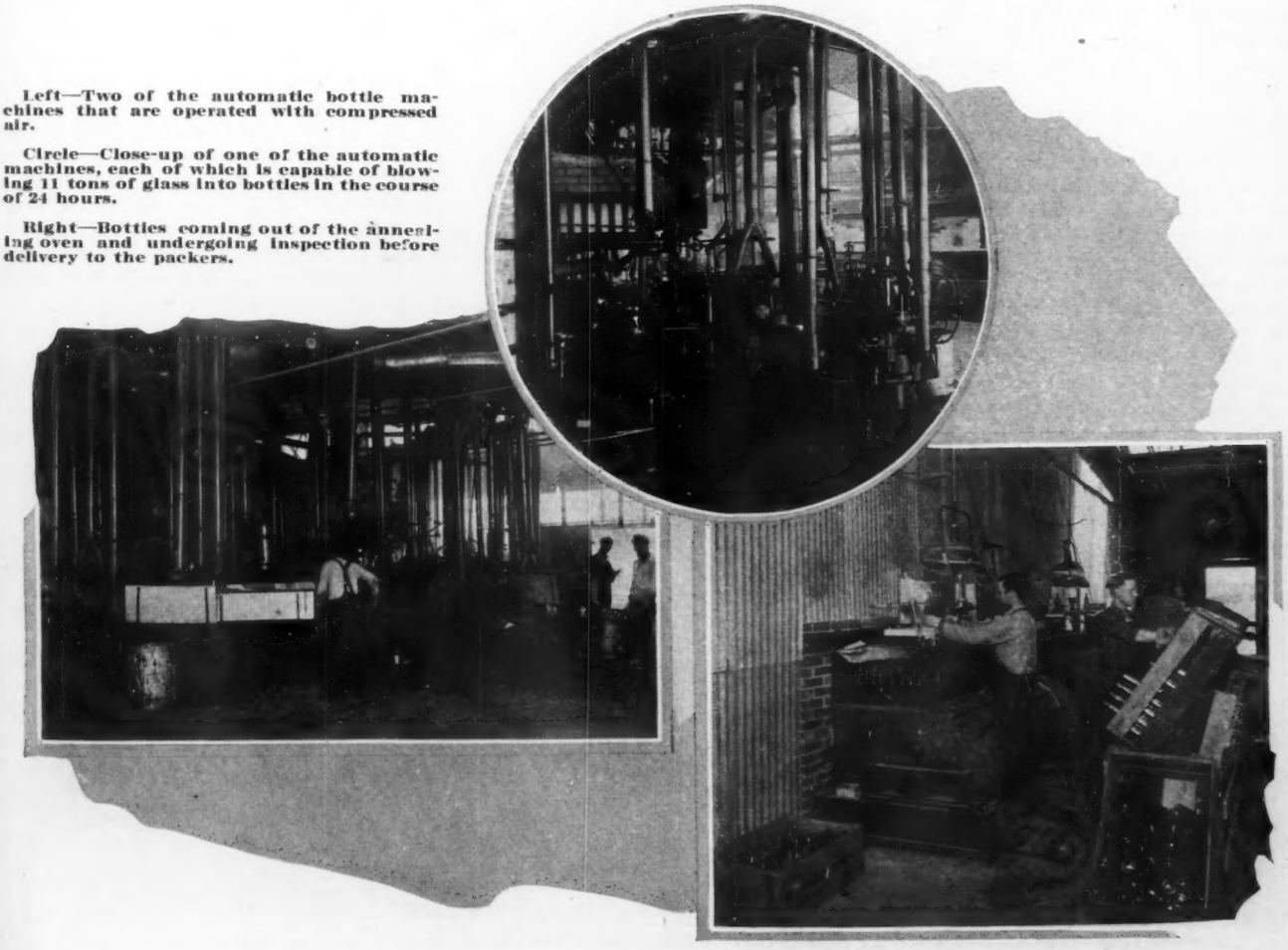
WHEN you wet your whistle with a soft drink, do you ever think of the many others that do the same thing? Have you any idea of the volume of these beverages consumed annually in America? It is officially declared that more than 11,000,000,000 bottles of drinks of this kind are distributed throughout the country in the course of a twelvemonth! This is the reflex of a law designed to minimize the consumption of spirituous liquors.

It is a matter of widespread knowledge that the grape growers of the United States loudly prophesied their industrial doom when prohibition was imminent; and yet it is a happy fact that the commercial vineyards of the nation are prospering today as they never did before. The bottle manufacturers of the country were similarly and equally gloomy when the dry law seemed inevitable; and, not without reason, they opposed the constitutional amendment that carried a possible menace to their business welfare. Despite that outlook, the production of our bottle plants has since grown amazingly with each succeeding year—prohibition has proved a boon rather than a bane to them.

On the basis of the foregoing figure, issued by a statistician of the United States Department of Agriculture, the per capita consumption of these beverages is at the rate of nearly 96 bottles per annum. If we exclude the infants that cannot so gratify their palates, it is safe to say that those that do indulge drink, individually, fully double that number of bottles of non-intoxicants in the course of a year.

In producing 11,000,000,000 bottles of soft drinks, the manufacturers employ, so a Government expert states, 250,000 tons of sugar, 5,000,000 pounds of fruit acid, 50,000 pounds of artificial coloring, 1,000,000 gallons of flavoring extracts, and the tidy volume of 400,000,000 gallons of carbonated water. Perhaps we can get a clearer idea of these vast quantities. All mixed and ready for bottling, this volume of soft drinks—if placed in a suitable reservoir—would be more than ample to float 25 ships of the size of the *Leviathan*! That great craft displaces 64,100 tons of water.

Whence come all the bottles required to hold the various beverages? How are they made fast enough and at a price to meet the needs of the trade? Manifestly, the demand cannot be taken care of by plants that turn out hand-blown bottles. The work, today, is done well-nigh entirely by factories equipped with automatic or semi-automatic bottle-blowing machines. The automatic bottle-blowing machine is a wonderfully ingenious affair; and the purpose of the present article is to describe a new plant that is equipped with machines of this character. We refer to the Mount Reed plant of the F. E. Reed Glass Company, Rochester, N. Y.



Left—Two of the automatic bottle machines that are operated with compressed air.

Circle—Close-up of one of the automatic machines, each of which is capable of blowing 11 tons of glass into bottles in the course of 24 hours.

Right—Bottles coming out of the annealing oven and undergoing inspection before delivery to the packers.

The two Ingersoll-Rand oil-engine-compressor units that furnish operating air for the glass plant.

That bottle factory started production in March, 1928; and, when working at maximum capacity, it will be able to turn out 55 tons of finished product in the course of 24 hours. As each beverage bottle weighs a pound, the output may be as high as 110,000 containers in the interval mentioned. Perhaps a better notion of what this means can be had if we follow the various operations through from the beginning to the end—taking them in their ordered sequence.

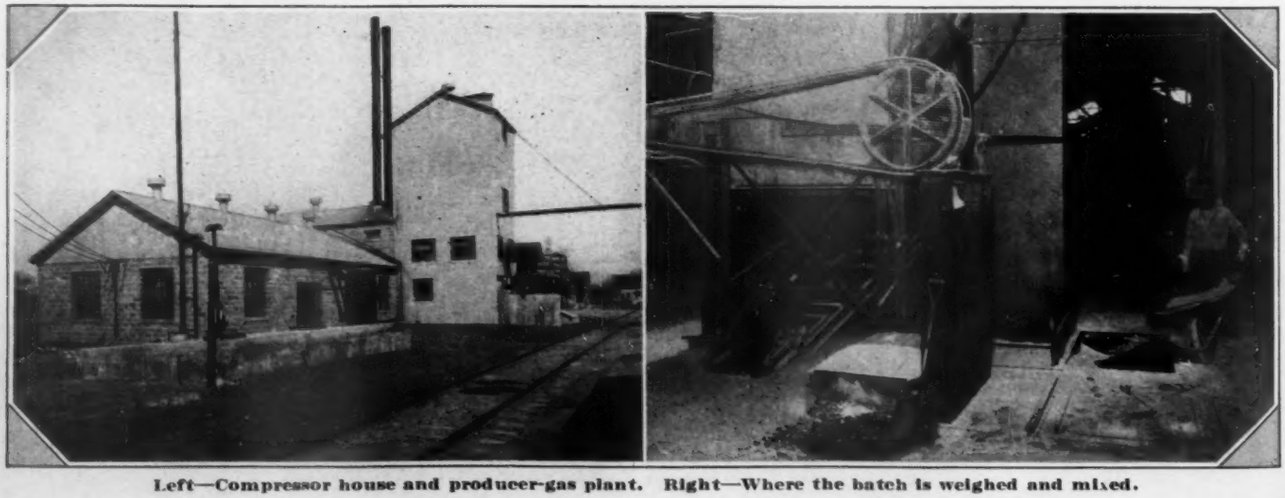
This up-to-date plant has a single continuous tank furnace in which the glass is melted and refined. The glass is what is known as a soda-lime glass, and is made up of soda, which serves as a flux: lime, which acts as a hardener; silica sand, which is the predominating and basic material; and about 1,300 pounds of cullet with each ton of sand. The glass is green; and this color is induced by the addition of a sufficient quantity of chrome. The tank is about 50 feet long; and the ingredients of the batch are mixed by hand on the floor and carried thence by a mechanical conveyor to the feeding end of the tank. When starting with a fresh batch, it takes 48 hours to melt the ingredients; and during that time the batch is continually exposed to a temperature of about 2,400° F. The furnaces are fired with producer gas made on the premises.

The continuous tank is capable of supplying molten glass in sufficient quantity to take care of five automatic bottle-making machines—each machine having a rated capacity of 11 tons of glass every 24 hours. At the present time, however, there are but three such machines installed. These are of the well-known Lynch model. These units perform with uncanny precision; and their various and interrelated functions seem dominated by a brain—such is the engineering cunning that has gone into their make-up. The different operations are timed by electric motors; but the actual working is effected with compressed air. A pressure of 40 pounds to the square inch is maintained in the service line.

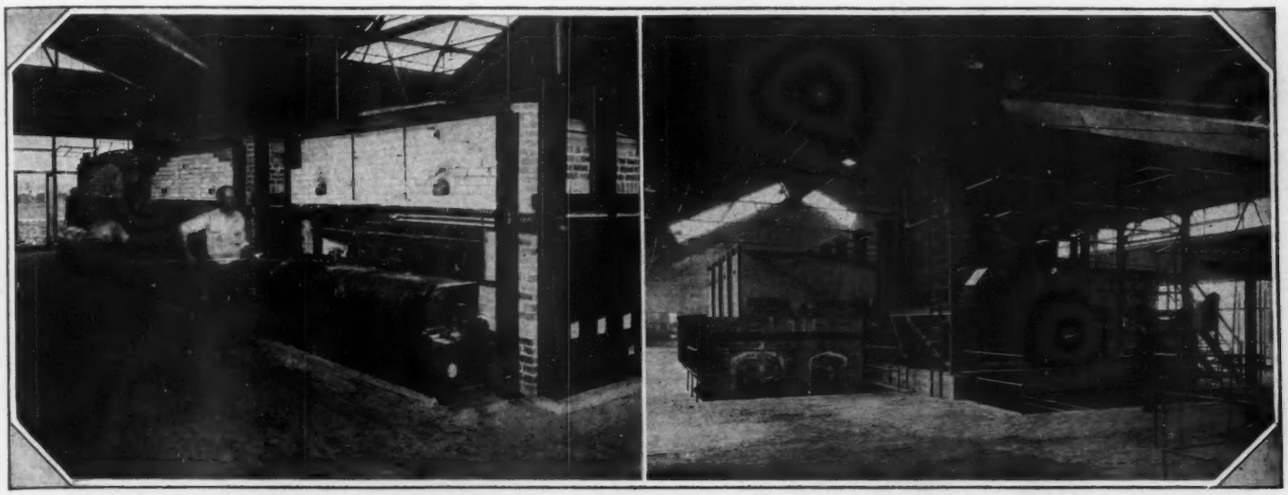
Each automatic machine is of the 2-table type; and a certain number of the essential operations is performed on each table. Perhaps it would be of interest to mention these in their respective order. The first operation consists in feeding gobs of glass of just the right size to form the bottles. These gobs are supplied by a feeding machine which draws the molten glass from the tank, cuts off a glowing ingot from the plastic glass, and drops it at the proper time into a "blank" mold as that mold revolves on the table and comes directly beneath the feeding machine. The molds, six in number, are split molds, hinged so that they can open and close at the right moment. Immediately after the mold has closed around the gob, air is blown down into it to form the top of the bottle. The third operation consists in blowing air up into the mold, to start the hole in the neck of the blank, and thence into the glass mass as a whole. The bottom of the bottle is shaped at the same time. In the fourth operation the mold is turned so as to deliver the partly made bottle upright to an opened mold on the adjoining revolving table.

On the second table are six finishing molds. After one of these molds closes about the forming bottle, air is blown into it in order to give the plastic glass its final desired shape by expanding it so that the resulting bottle will conform to the enveloping cavity of the finishing mold. With this done, more air is applied to cool and to stiffen the glass. In the sixth operation the mold opens, and air-actuated mechanical fingers pick up the bottle and transfer it to an air-driven conveyor which carries it to a point where a number of them can be stripped off on a metal scoop and taken promptly thence to the admission end of the annealing furnace or lehr, as it is known to the industry. Each bottle remains in the lehr for a period of six hours. The temperature of the lehr is 1,200° F. at the receiving end and drops gradually to that of the shop by the time the conveyor delivers the bottle at the discharge end. From entrance to exit of the annealing furnace the bottle makes a journey of 70 feet.

As the bottles reach the discharge end of the lehr they are quickly removed by attendants. Next they are inspected by trained workers who weigh the bottles to see that they are according to specifications and further



Left—Compressor house and producer-gas plant. Right—Where the batch is weighed and mixed.



Left—The feeding end of the big lehr or annealing oven. Right—Rear view of the gas-fired tank that furnishes glass to the bottle-making machines.

determine their fitness by sound and sight tests. Four bottles are handled simultaneously in making these examinations. Bottles that are unsatisfactory are scrapped and carried to the cullet pile for reworking into glass, while those that pass the inspection are just as promptly ranged in suitable wooden crates to be sent by gravity, on roller conveyors, to the packing department.

Besides performing the various services that it does on the two tables of each bottle-making machine, compressed air operates the feeder on the glass feed tank and atomizes the oil jet for the flame that keeps that feeder sufficiently hot to handle the molten glass without chilling it before the gobs are cut and dropped into the receiving molds. In fact, every function in connection with the mechanical blowing of bottles depends upon the maintenance of a temperature suitable to that particular phase of the work, as well as upon the extremely nice coördination of the interrelated operations.

Manifestly, the air supply of the plant is of the utmost importance; and to make sure that there will always be enough of this to meet requirements, the factory is provided with two Ingersoll-Rand POC-1 oil-engine-compressor units. One of them is ample to take care of the maximum demands, but two are installed to insure an unfailing output should one or the other of the machines be idle for any reason. As a matter of practice, the compressors are run alternately. At the present time, when running at a load factor ranging between 65 and 70 per cent, one of these 110-hp. units will consume 4 gallons of fuel per hour. The piston displacement is equivalent to 640 cubic feet of free air per minute. The lubricating oil for the compressors is changed once a month; and during the working period it is kept fit for continuous service by means of a bag filter.

The water at the inlet of the compressor jackets has a temperature of 55° F. as it comes from the softener, and as it leaves the engine jackets it has a temperature of 120° F. At that temperature, it is delivered to a Davis generator which utilizes the heat of the exhaust gases from the operating engine. This generator brings the temperature of the water up to 145° F.; and such is its condition when it enters the boiler feed pump that it takes care of the steam plant of the factory. Steam is used to heat the bottle works in wintertime and to feed the producer-gas plant on the premises. The water discharge from the compressor jackets averages about 6 gallons per minute. During mild weather, approximately 3 gallons of this water goes to the boilers and the remainder is emptied into a sewer. During the winter months, however, when the heating load is added, all the water is utilized by the boilers.

Under mild weather conditions, and by raising the temperature of the water 90° through the use of the engine exhaust, it is possible to increase the boiler efficiency about 10 per cent by feeding the boiler hot instead of cold water. With coal at $5 a ton, let us say, the saving made in this way amounts to $1.25 a day. This is based upon a 60-hp. boiler running at 80 per cent of its load factor. Assuming a working year of 300 days, the total saving by this use of the circulating water of the compressors would be $375. This sum can be added to the economies brought about primarily by the employment of oil-engine drive.

SHAFT-SINKING RECORD ON THE RAND

THE sinking of the No. 4 Shaft of the Springs Mines, Ltd., on the Witwatersrand has been watched with considerable interest in mining circles because of the speed with which the crews have been working their way downward to the main gold-bearing reef, which is said to lie 4,200 feet below the surface. In four months, from March 1 to June 30, 1928, the drillers—using N-73 drifters with sinker handles—increased the depth of the shaft by 1,147 feet, or an average of 287 feet per month. The achievement is said to mark a record in shaft sinking in Africa; and W. F. de Jaeger, the master sinker in charge of operations, is justly proud of the performance of his men and of the equipment that helped to make it possible.

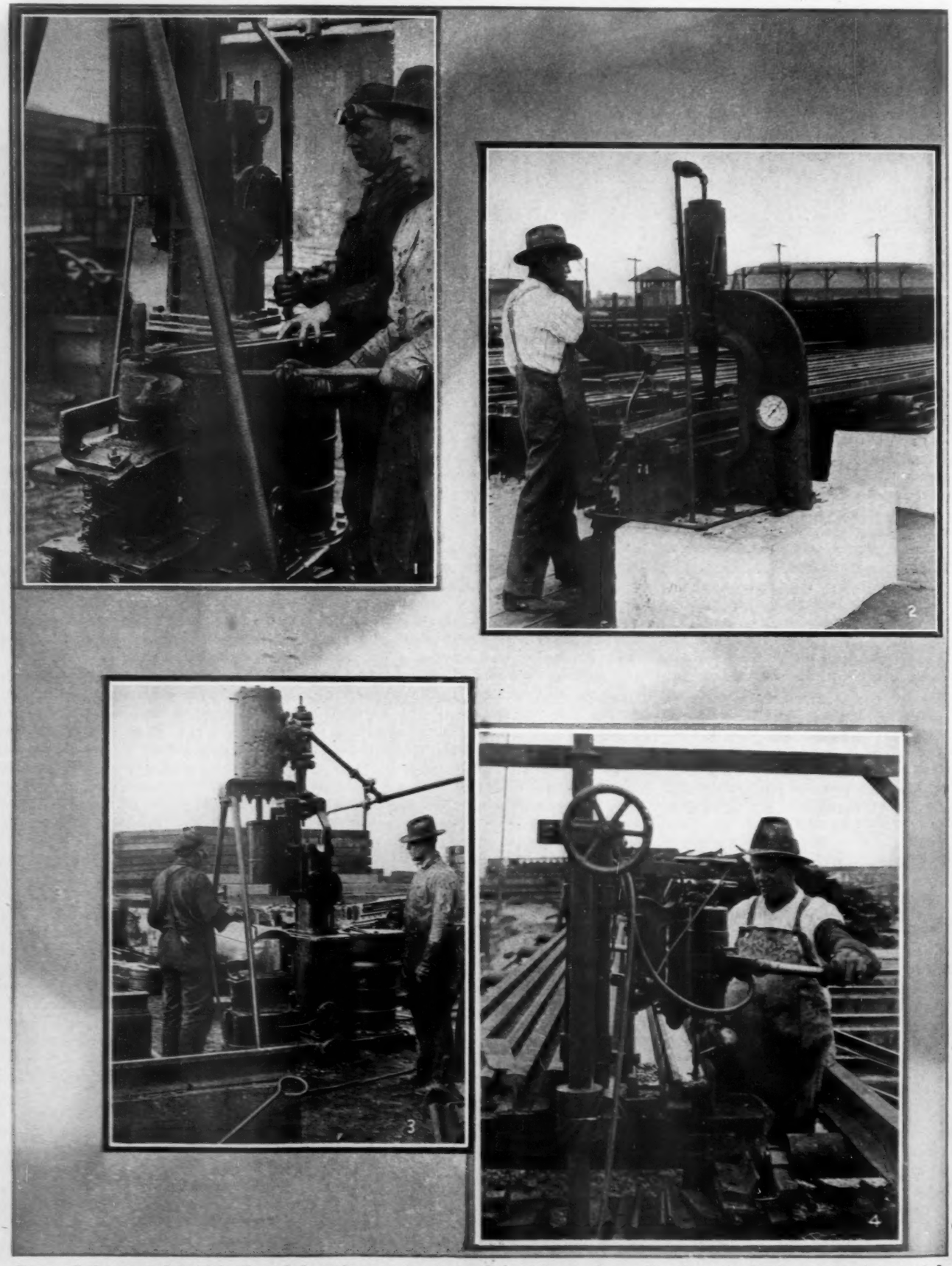
Up to June 30, the best showing was made in May, when the shaft was advanced 300 feet in 31 working days; or an average of 9.68 feet a day. In March it was sunk 286 feet; in April, 279 feet; and in June, 282 feet. Operations have been carried on in three 8-hour shifts by crews each made up of a sinker, a helper, and a gang of 42 boys. The first 5½ hours of each shift was given over to mucking, lashing, etc., and the remaining 2½ hours to drilling and blasting. Each round consisted of from 72 to 84 holes; and ⅞-inch hollow, round steels were used in the N-73 drifters, of which seven were on the job.

No. 4 Shaft of the Springs Mines is vertical, 31x13 feet in cross section, and divided into five compartments. As the work proceeds, it is being lined with timber and finished with guides. Sinking operations were begun at the end of April, 1927; and, if the same rate of progress has been maintained in the meantime, the shaft should be completed some time this month.

TO INVESTIGATE SERVICE LIFE OF WIRE ROPE

THE study of wire rope and of the factors governing its life is to be undertaken by a research committee of the American Society of Mechanical Engineers under the sponsorship of the Engineering Foundation. Many miles of wire rope are required annually in the United States for numerous purposes; and users have found that its life in service varies greatly. Why this should be so, has never been clearly understood.

To throw some light on the matter, both makers and users of wire rope have expressed their willingness to support the large-scale investigations proposed by the aforementioned society. It is planned, among other things, to construct a testing machine capable of reproducing at will the different service conditions under which wire rope is called upon to work. As rope of this kind largely affects the safety of lives and property, the subject is one that should interest everyone.



Some of the ways in which discarded equipment has been adapted for use in a railroad repair plant. 1—An air-operated machine for reclaiming coupler knuckles. 2—A pneumatic rail straightener. 3—An improvised air-driven apparatus that builds up worn coupler-knuckle pin holes. 4—This tool makes short work of drilling rails.

What I Know About the Barometer

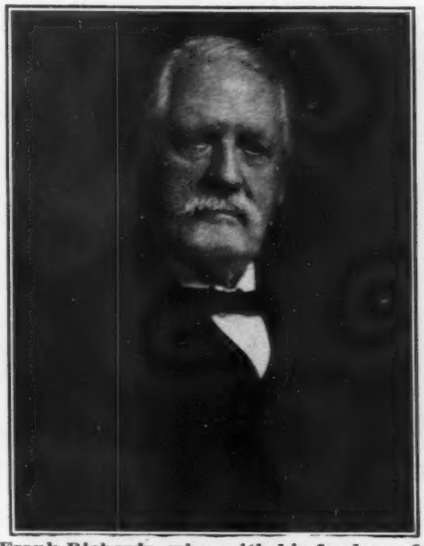
By FRANK RICHARDS

IN the story of world activities in recent years, compressed air has figured quite conspicuously; and not many of our most notable achievements are now accomplished without its aid. Compressed air, however, as a handy helper, is still regarded as more or less of a novelty and as only a recent addition to the world's kit of tools wherewith to work its wonders. But it is a curious thing that all the air with which we come in contact—and whose services are so numerous and diverse—is, always has been and always will be compressed air, compressed at least by the weight of all the air above it. Hence, we are all born compressed-air workers. Non-compressed air can hardly be imagined, and can never be discovered or produced.

It was through compressed air that Lindbergh made his lone flight to astonish the world and to give to the present century the record of the greatest feat of all the ages. Perhaps not even he has thought of the fact that that flight through the air could never have been made without the constant testimony of his air-pressure gage, which told him the precise state of compression of the air through which he was rushing and, inferentially, the precise height at which he was flying so that he might not dash into the waves but, instead, be able to choose the elevation which would best serve and hasten his flight.

The air-pressure gage upon which all aviators must depend is not generally known by its clearly descriptive title. It has been called a barometer, and, later, an aneroid barometer—both terms conveying no obvious meaning except to the initiated. The mercury barometer is nearly three centuries old, and the aneroid barometer is less than one century old. Only the latter is available for universal use.

Like other of the world's greatest acquisitions, the barometer did not at first show us all that it could do, or even what it could do best; and its value to us has been long in receiving deserved appreciation. It was found, in a general way, that the higher atmospheric pressures for any locality promised fair weather, and that the lower pressures portended rains and storms. Accordingly, the barometer was generally known as the "weather glass", and as little more than that. But to prognosticate the weather from barometer readings involves the consideration of several other accompanying conditions, such as the temperature and the atmospheric humidity, the force and the direction of the winds, the movement of the mercury column—whether slow or rapid, upward or downward, etc. Thus, while trained scientists and widely informed observers may forecast the weather with some success, it is little better than guesswork for the amateur.

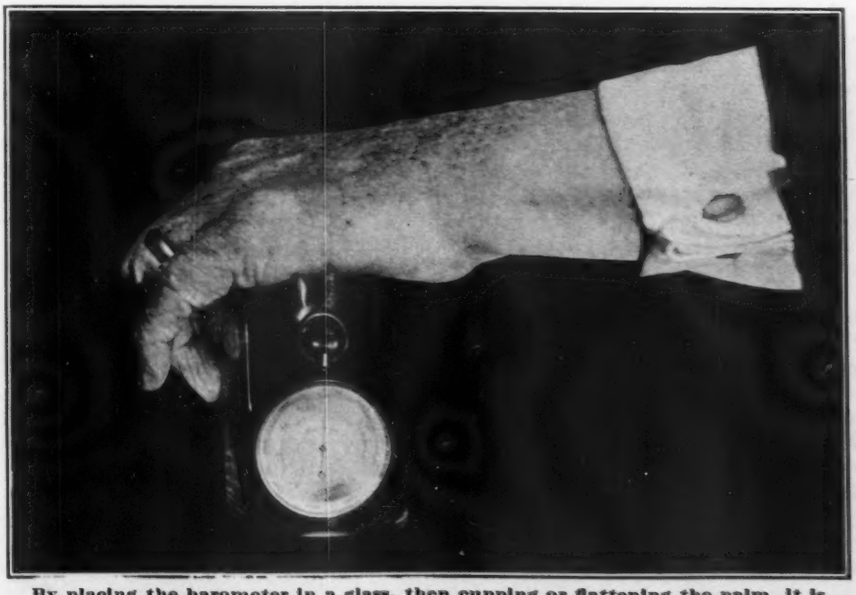


Frank Richards, who, with his fondness for precision, tells us he will be 89.8 years old upon the appearance of this issue of the Magazine.

In the earlier days of the first barometer it was learned that the reading varied with any decided difference in altitude—the mercury column descending as the instrument was carried higher, and rising when conveyed to lower levels. Therefore, it could be serviceable in measuring altitudes, at least approximately, anywhere. Not much could be done in this line with the mercury barometer, however, as it is not conveniently portable. It must be placed in a vertical position; and the height of the column cannot be read with sufficient accuracy. The aneroid barometer completely satisfies every requirement. It is always ready without any care or adjustment; it can be carried and employed in any position; gives its indications with the most minute precision; and can be made self-recording. It has, of course, come to be used as an altimeter wherever needed; and, was opportunely ready for the aviator when he went into business. To him it is an indispensable instrument.

It will be convenient in this connection to call attention to my pocket aneroid barometer which I have carried or have had hanging at my desk for 25 years. In all that time it has gone along without any adjustment or care—giving its indications as unfailingly as a thermometer. It weighs only 3 ounces, or just half as much as my big watch. The face is graduated to show the air pressure in inches of mercury—that is, from 25 to 31 inches. If I should take the instrument down into a deep mine, the pointer at the increased pressure would move beyond the latter figure; but that higher reading is not provided for.

Atmospheric changes of pressure are generally very slow, and also not of great extent. Sometimes there is no apparent movement of the pointer all day, and it seems as if the instrument were dead; but I have often tried the trick shown in one of the accompanying photographs, and at once realized that the barometer is very much alive. By standing the aneroid in an empty tumbler and putting my hand over the top, covering it entirely, and then by merely changing the hollow in the palm of my hand to increase or to diminish the air pressure a little, I find the pointer immediately responsive and prompt to move in either direction. My great-grandson, ten years old, one day placed his mouth over the top of the glass and by alternately blowing and drawing in his breath moved the pointer much farther than I



By placing the barometer in a glass, then cupping or flattening the palm, it is possible to induce a noticeable movement of the pointer.

could by the action of my hand.

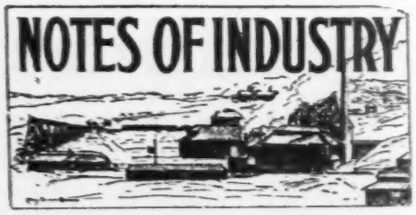
Surrounding the dial, which is graduated to give the pressure readings in inches and tenths of inches of mercury, there is a flat ring made to rotate in either direction by turning the knurled handle which looks like the knob of a stem-winding watch. The ring has a zero mark upon it which may be set exactly with the pointer whenever the instrument is inspected; and any movement showing a change of atmospheric pressure will be evident at the next observation. In my present home location in New Jersey, near sea level, the entire range of my local barometer readings is from, say, 28.5 inches to 30.5 inches—the interval representing very closely 1 pound of air pressure per square inch; and, wherever any of us may be living, this is nearly the normal range for all of us. The record for months at a time with me is between 29 inches and 30 inches or ½ pound of air pressure. It is in the altitude business that the barometer shows what fine work it can do, and how minutely accurate it can be. For that purpose, the adjustable ring spoken of is graduated all around the circle to show altitudes ranging from hundreds of feet up to thousands of feet.

This pocket aneroid barometer weighs only 3 ounces.

The instrument to which the aviator trusts his life is larger than my pocket affair; and its readings extend as much farther upward as may be required. When it is made self-recording it becomes a barograph. In the passenger elevator of a skyscraper, with my aneroid in my hand, I can detect changes in height as little as 25 feet; but altimeters are made which will show differences of even 5 feet up or down. The air pressure corresponding to this minute interval might be 0.0025 pound per square inch, which would seem to call for a mental microscope.

I would like to call attention to another field of service for the aneroid which also has developed in recent years, and that is in indicating the ups and downs of the automobile. To the touring automobilist, especially, this should appeal strongly. We cannot travel far, going through several states or across the continent in either direction, without having to traverse regions more or less hilly or even mountainous; and our curiosity must often be stirred to know how high we may have had to climb or how far we may have had to go down.

But there is a more practical side than that. The record of a car's horizontal travel is essential for various reasons; but what about its vertical mileage? An auto may weigh two tons or more, and it should be remembered that that weight has to be raised and lowered continually as we speed up and down even ordinary hills. Under these circumstances, the power demands upon the motor are far greater than those made by the car when running on a level road; and the aneroid, with its cumulative record, would surely astonish us.



Oil fields of great promise have been discovered in Bolivia, according to an announcement made by the Director General of Mining and Oil.

The completion of the Gaspé Belt Highway, by the Province of Quebec, has opened to the touring public a road nearly 1,000 miles long and extending from Montreal to the Gulf of St. Lawrence. The new link in this scenically beautiful highway is 400 miles long and runs east from Cape Chat along the St. Lawrence for about 200 miles, thence turning inland and joining the Montreal-Quebec-Rimouski Highway.

In order to cope with the activities of the aviation industry, the Aeronautical Chamber of Commerce of America proposes to establish six branches throughout the United States and to put the organization on a national instead of a local basis, as is now the case. According to those officials, the industry has expanded tremendously—the value of the output within the last eighteen months having increased from a few million dollars a year to more than $100,000,000 a year.

Where it is necessary to drop water 100 feet or more to a pumping level it can be utilized to furnish power by conducting it through small-diameter pipes instead of allowing it to reach the sump by way of stopes and raises. One mine uses such power to drive a fan, *Engineering and Mining Journal* announces, and another operates a generator supplying electric light to several stations in the workings.

A single-deck street car has been put in service in Dresden, Germany, that is 75 feet long and capable of seating 117 passengers.

It is reported from abroad that a Diesel type airplane engine, using heavy oil, has been developed in Germany. The engine is said to weigh 1,400 pounds and to develop 60 hp.

Borium, a manufactured product possessing a hardness between that of a sapphire and a diamond, is claimed to be a satisfactory substitute for black diamonds now generally employed in core drilling.

For some years the Indian Government railways have been experimenting with systems designed to light the exteriors of trains for the purpose of intensifying the illumination at country stations and as a safeguard against trespassers. Two or more lights are provided on each side of a carriage, and these are automatically switched on when the train is running below a certain speed and switched off when the prescribed limit is exceeded.

We have been hearing much of late about the virtues of the cornstalk, and now, in evidence of the assertions made by Government and other experts, we are advised that plants have been erected for the manufacture of wall board and paper in Dubuque, Iowa, and Danville, Ill., respectively. The practicability of the processes used is being vouched for by the Chemical Engineering Department of the Iowa State College.

The nation's ice bill for 1928 is estimated at $430,000,000, an increase over the 1927 consumption of more than 33⅓ per cent. Even so, reports the National Association of Ice Industries, only 42 per cent of the American homes use ice boxes.

Passenger elevator cages of nickel are advocated because they are of lighter weight than those of steel, and therefore need far less power to move them.

Compressed Air Magazine

—Founded 1896—

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EDITORIALS

SPOKEN WORDS EVERLASTING

SOMEWHERE in the space that envelops the earth the words of MOSES go rippling onward—such is the deathlessness of speech according to certain radio technicists! Most of us have a pretty good opinion of that ancient prophet and leader, and most of us would hate to have him discredited by making vocal again words possibly uttered by him in a moment of pique and not intended for publication. One and all of us would certainly regret it should the scientists of radio find ways by which words spoken in the past could be brought to life to confront us in the present. Just think what would be our lot if we tuned in inadvertently upon some of the political harangues with which we have so recently been pestered. Most of the owners of radio sets bought them for entertainment and not for punishment.

We have it on good authority that 41,000,000 people in the United States could listen in on nationwide broadcasting if all their sets were used simultaneously; and in the course of the last eight years the people of this country have spent substantially $2,000,000,000 in providing themselves with radio sets. No wonder the business of producing such equipment has developed into an industry of notable proportions. The problem now is essentially one of finding ways to so control this use of the ether and radio waves that the broad results will be beneficial. This is not an easy matter; but, even so, the education, the daily dissemination of information, and the entertainment of many millions of persons depend upon the discovery of a satisfactory solution. We heartily wish those responsible for the outcome success in the task that is or will be theirs.

CANADA GOES STEADILY FORWARD

A PROSPEROUS and prospering nation makes the best of neighbors. Happily such is Canada's status and friendly nearness to us. Canada's growth industrially and economically is proof of what a sturdy and well-directed people can do in overcoming difficulties and in turning Nature's rugged gifts to good account.

It is within the memory of many of us how strenuously a considerable group of Canadians urged annexation with the United States as recently as three decades ago—speaking of such a union as "a perennial honeymoon of prosperity". Fortunately for both nations, the Canadians as a whole wisely decided to continue on alone in solving their problems; and the world today can see how amazingly well they have succeeded in making themselves strong enough to stand firmly on their own legs. As neighbors, each of us can benefit through the reciprocal relations that have developed.

Today, Canada ranks fifth in world trade, whereas only fifteen years ago her position was tenth in international commerce. Canada's prosperity is reflected in what she buys from us: she is now our best customer. During the twelve months of the fiscal year that ended June 30, 1928, Canada bought goods from us to the total value of $852,000,000. The Dominion's capacity to draw upon us to this extent is a sure sign of her industrial progress, because, in the last analysis, her fiscal strength rests upon what her farms, her factories, and her mines are contributing to her rapidly increasing wealth.

According to competent authorities, Canada's mines and quarries will yield during the current calendar year products having an aggregate value of $260,000,000. This represents an increase of 5 per cent upon the output of 1927 and an advance of 23 per cent upon the total production of ten years ago, when prices were notoriously inflated. We are informed that precious metals are expected to contribute $52,000,000 of the sum mentioned; that the four principal base metals mined in the country will probably yield $72,000,000; that the coal output will have a value of $60,000,000; and that the combined worth of other non-metallic minerals will be substantially $76,000,000. Surely, this is a splendid showing.

Canada's achievements in the field of mining have, in many instances, been won against great physical odds. Equipment, and much of it, has had to be transported long distances into wilderness regions often far from railhead, taxing perseverance and resourcefulness to the limit. Fortunately, modern mining machinery of various sorts could be moved to these remote and far-flung industrial battle fronts; and these labor-saving aids in the form of air-driven rock drills, portable compressors, and oil-engine prime movers have neutralized nature's handicaps and made profitable accomplishment possible. To this extent, present-day engineering has robbed the pioneer's work of some of its hardships and has enabled Canada to forge forward at an amazing pace.

"GRAF ZEPPELIN" COMPLETES ROUND TRIP

EVERYONE interested in aviation will acclaim the safe return of the *Graf Zeppelin* to Germany after twice crossing the Atlantic Ocean. The performance of the giant airship indicates that much has been achieved in this method of aerial transportation since the *R-34* made the round trip between the British Isles and the United States in the summer of 1919. What the *Graf Zeppelin* has done in capable hands plainly marks a long step forward in the commercial utilization of this form of aircraft in the carriage of passengers, mail, and express matter.

In order to make her two crossings practicable, her constructors found it desirable to modify in various ways the designs previously developed for airships of that particular pattern; and they did this skillfully and effectively. Furthermore, to neutralize the expenditure of fuel and the incidental reduction of the dead load, they found ways to utilize "blau" gas instead of gasoline for the propulsive engines during the major part of each leg of the round trip. By recourse to a gas having nearly the specific gravity of free air, the weight of the expended fuel could be replaced with an equal volume of air. This meant that the reserve of buoyancy of the dirigible could be held fairly constant; and none of her sustaining hydrogen needed to be released to offset a loss of weight incident to consumed fuel, as would inevitably be the case with gasoline as a source of power. This is not merely a technical achievement—it is a practical gain bearing directly upon the employment of such aircraft in commercial service.

It has been estimated that at the rates charged for passengers and postal matter the gross revenue earned by the *Graf Zeppelin* on her maiden round trip was approximately $250,000; and it is reasonably certain that the dirigible cost in the neighborhood of $1,250,000 to build and to equip. Apparently, the ship would not have to make many crossings to pay for herself, assuming that transportation charges for mail and passengers remain as on the initial runs. Manifestly, this is unlikely to be the case, because popular enthusiasm largely accounted for the rates paid for the privilege of being identified with that spectacular essay. Unquestionably, the charges will have to be lower—much lower—to satisfy the public when the novelty of the thing wears off.

The fact that the weather plays a far bigger part in the navigating of a dirigible airship than it does in an ocean-going liner emphasizes the limitations of this mode of long-distance transportation. What may yet be accomplished towards offsetting this handicap only the future will show; but we do know that an airplane made a non-stop flight across America at the very time that the *Graf Zeppelin* was held in her hangar and her trip to the Middle West was cancelled because

of weather conditions. In fact, Doctor ECKENER then declared that it would be impossible to withdraw the *Graf Zeppelin* from the sheltering hangar at Lakehurst. This is not said for the purpose of detracting in the least from what the *Graf Zeppelin* typifies in the way of aviation progress, but merely to evaluate the present state of the art. Every milepost is a mark of advance, but not every milepost is near the goal. We believe that outstanding and very substantial improvements are yet to be made before airships of this sort can be counted upon for regular commercial service.

NURSES IN INDUSTRY

THE employment of nurses in large business offices and industrial plants was given an added impetus at a recent luncheon held in Brooklyn, N. Y., under the auspices of three New York State nursing organizations. The movement, which is nationwide in its scope, has already received well-deserved recognition; and in the City of Greater New York, alone, more than 300 graduate nurses are engaged in looking after the welfare of men and women working in factories, stores, and offices.

Recent Government statistics show that an average of 2,500,000 persons in the United States are continually prevented from going to work on account of illness or accident. The figures also disclose that for every one disabled because of an accident, six or seven are incapacitated through illness. By employing nurses, and by training the wage earners to go to them at once for advice or attention, the nation's sick list of the gainfully occupied can be reduced greatly and industry saved millions of dollars yearly.

FREDERICK KENT COPELAND

WE regret to announce the death on November 10, at Claremont, N. H., of Frederick Kent Copeland, president of the Sullivan Machinery Company. Mr. Copeland was born on August 22, 1855, at Lexington, Mass.; and he was a graduate of the Massachusetts Institute of Technology.

Mr. Copeland began his business career in 1876 in the operating department of the Chicago, Burlington & Quincy Railroad. From 1878 to 1884 he was actively engaged as a mining engineer in the states of Iowa and Colorado, and in 1884 he organized the Diamond Prospecting Company. Eight years later that company was merged with the Sullivan Machinery Company, with which Mr. Copeland was identified from that time on until his demise.

Mr. Copeland was a well-known figure in mining circles. He was a member of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the Western Society of Engineers.

It is reported that a German company has made arrangements to distribute liquid oxygen anywhere throughout the Reich in specially constructed motor tank cars.

CORN FROM EGYPT, by Maurice Gompertz. An illustrated book of 88 pages, published by William Morrow & Company, Inc., New York City. Price, $1.00.

THIS little volume is one of several included in *The Beginning of Things Series*, and deals with the origin of agriculture. Despite the fact that hundreds of millions of us depend for our food upon the industry of the tiller of the soil, there was a time when people did not practice agriculture; and, strange as it may seem, there still are parts of the world where whole communities do not cultivate the ground. Therefore, it should be a matter of interest to learn something about the origin of agriculture and when man first essayed to subject plants and animals to a system of domestication that would place them at his service. Mr. Gompertz has given us an interesting and an informative picture of agriculture in the days of ancient Egypt.

HOW TO SOLVE TYPICAL BUSINESS PROBLEMS, by William R. Basset. A work of 223 pages, published by The B. C. Forbes Publishing Company, New York City. Price, $2.50.

AT the very beginning of Chapter I, the author states: "Even after twenty-five years of more or less scientific thinking and experimenting along business lines, business is still, as a whole, full of cobwebs". The book is, therefore, intended to help the business world to brush aside these hampering cobwebs; and, if lucid presentation of the subject will suffice, the present volume should go a long way towards clarifying the industrial situation. The chapters deal with selling at a profit; commonsense in selling; the sound labor policy; the commonsense way to pay wages; buying for profit; the sensible credit policy; what finance really is; getting executive leadership; making the factory a tool of production, etc., etc., etc. There is a helpful lesson in every chapter.

REPRESENTATIVE INDUSTRIES IN THE UNITED STATES, edited by H. T. Warshow. An illustrated work of 702 pages, published by Henry Holt & Company, New York City. Price, $5.00.

THIS book is a collection of articles dealing with 21 of America's outstanding departments of industry—each topic being presented by a competent authority. The subjects handled include those industries that are engaged in the production of aluminum, automobiles, chemicals, copper, iron, leather, lumber, and petroleum, as well as the construction industry, the electric industry, the meat-packing industry, the water-power industry, etc., etc.

The comprehensive nature of the topics considered is calculated to furnish interesting reading for a very wide circle; and the manner in which each subject is handled assures this. The book is a worthwhile cross section of our industrial life.

EXAMPLES OF LETTERING AND DESIGN, by J. Littlejohns. An illustrated work of 59 pages, published by Isaac Pitman & Sons, New York City. Price, $1.25.

NUMEROUS books have been published on the subject of lettering, but most of these are intended to aid the draftsman or other professional workers. In the present instance, the author has sought to aid those who desire to do decorative writing for the pleasure of its artistic expression. In addition to illustrating the ways, and means, and forms having to do with lettering, the author has suggested methods for personal variations so that the handiwork of each may be given individuality. We believe this little book will be welcomed by all who have any desire to acquire facility in the making of artistic letters.

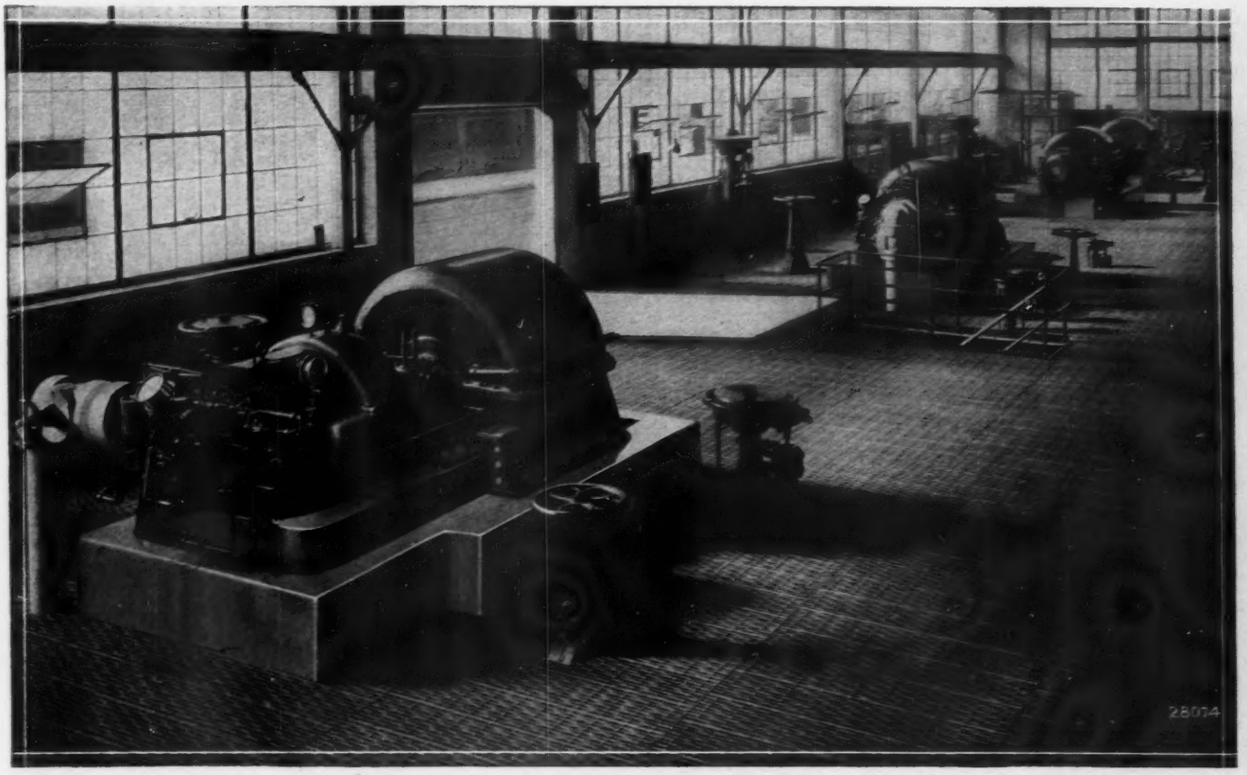
THE FALLS OF NIAGARA, by Glenn C. Forrester. An illustrated book of 155 pages, published by D. Van Nostrand Company, Inc., New York City. Price, $2.50.

TO most of us Niagara Falls are an impressive spectacle of the irresistible and amazing power of nature. We look upon them as a present fact, and but relatively few of us ponder upon their past. Mr. Forrester reveals that the falls mark some of the stepping stones leading to the remote history of this earth on which we dwell. He asks: "Did you know that the Niagara Falls were once at Syracuse, 171 miles away? That Niagara was once a sheet of ice 3,000 feet thick, and that at another time it was at the bottom of a semi-tropical sea in which coral reefs grew and strange life thrived?" The work is filled with thrilling revelations.

Coördinating Competitive Engineering is the title of a paper read by Frank W. Skinner, consulting engineer, before the Brooklyn Engineers' Club. Briefly, the purpose of this excellent exposition is to deal with the relative merits of steel and of concrete in construction work, and to point out the controlling conditions effecting a choice of material. The topic is one that has engaged the attention of Mr. Skinner for a good many years; and he has written with the authority of ripe experience. The paper is distributed as a reprint of the proceedings of that organization.

Pneumatic Diggers is the title of a bulletin lately issued by the Ingersoll-Rand Company, 11 Broadway, New York City. A copy of this bulletin will be sent free to any responsible person desiring it. It describes seven sizes of pneumatic diggers suitable for a wide range of work.

The Elesco Superheater for Power Plants is the title of Bulletin T-1 issued by the Superheater Company, 17 East 42nd Street, New York City. This illustrated publication describes the design, construction, and application of the Elesco superheater to power plants. Copies can be had free upon request.



Four of the 15 Ingersoll-Rand Turbo-Compressors used by the Los Angeles Gas & Electric Corp.

Supplying Los Angeles with Gas

The Los Angeles Gas & Electric Corporation supplies a large quantity of gas to domestic and industrial users in Los Angeles and vicinity. The plant generating capacity is approximately 100 million cubic feet per day.

Much of this gas is handled at the plant with Ingersoll-Rand equipment. In total, the Los Angeles company operates 15 Ingersoll-Rand Turbo-Compressors which have a combined capacity of 12 million cubic feet per hour at 3 pounds discharge pressure. The first of these machines was put in service in 1919; the others have been added as the plant output increased. Seven are driven by steam turbines and eight by motors.

Ingersoll-Rand furnishes compressors to meet every condition of gas compression. Our engineers will be glad to help you with your problems. Branch offices are conveniently located in all sections of the country.

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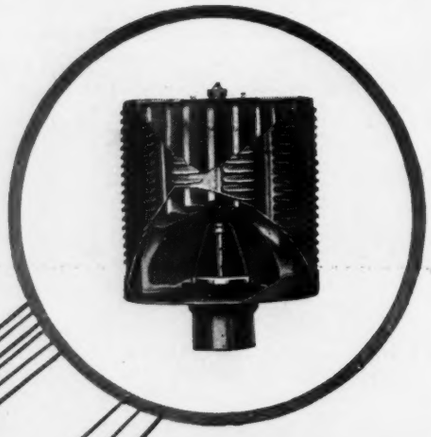
They Safeguard the Lives of Over a Thousand Men



More than one thousand men—working in the new tunnel being dug under the East River, New York—could be drowned like rats if the compressors, which supply compressed air to keep water out of this tunnel, should suddenly fail to operate. To assist in preventing such a catastrophe, Mason & Hanger Company, Inc., the Engineers and Architects, installed nine Protectomotor Air Filters, (with a combined capacity of nearly 40,000 C. F. M.) to keep dust and cinders from nearby stacks from getting into their compressors and scoring the reciprocating parts and causing carbon.

The construction of such a gigantic tunnel is not entrusted to amateurs. And when such well-known Engineers and Contractors as the Mason & Hanger Co. have sufficient confidence in Protectomotor Air Filters to select them for such important work, you may be sure they were positive that these filters would deliver clean air to their compressors.

Protectomotor Air Flters are guaranteed to deliver air 99-9/10% clean, and to reduce carbon deposits 60 to 70%. Wear on moving parts is thereby reduced as much as 75 to 85%, and pneumatic equipment will operate three to five times longer before overhauling is needed.

Over a quarter of a million Protectomotors are in use on compressors, engines, blowers, compressed-air tools, automobiles, trucks, etc.

PROTECTOMOTOR PIPE LINE FILTERS

These filters deliver clean, dry air—free from dust, water, oil, rust and scale—for paint spraying, cleaning operations, agitating liquids, hoists and compressed-air tools.

Our Catalog will be sent on request. Write for a copy.

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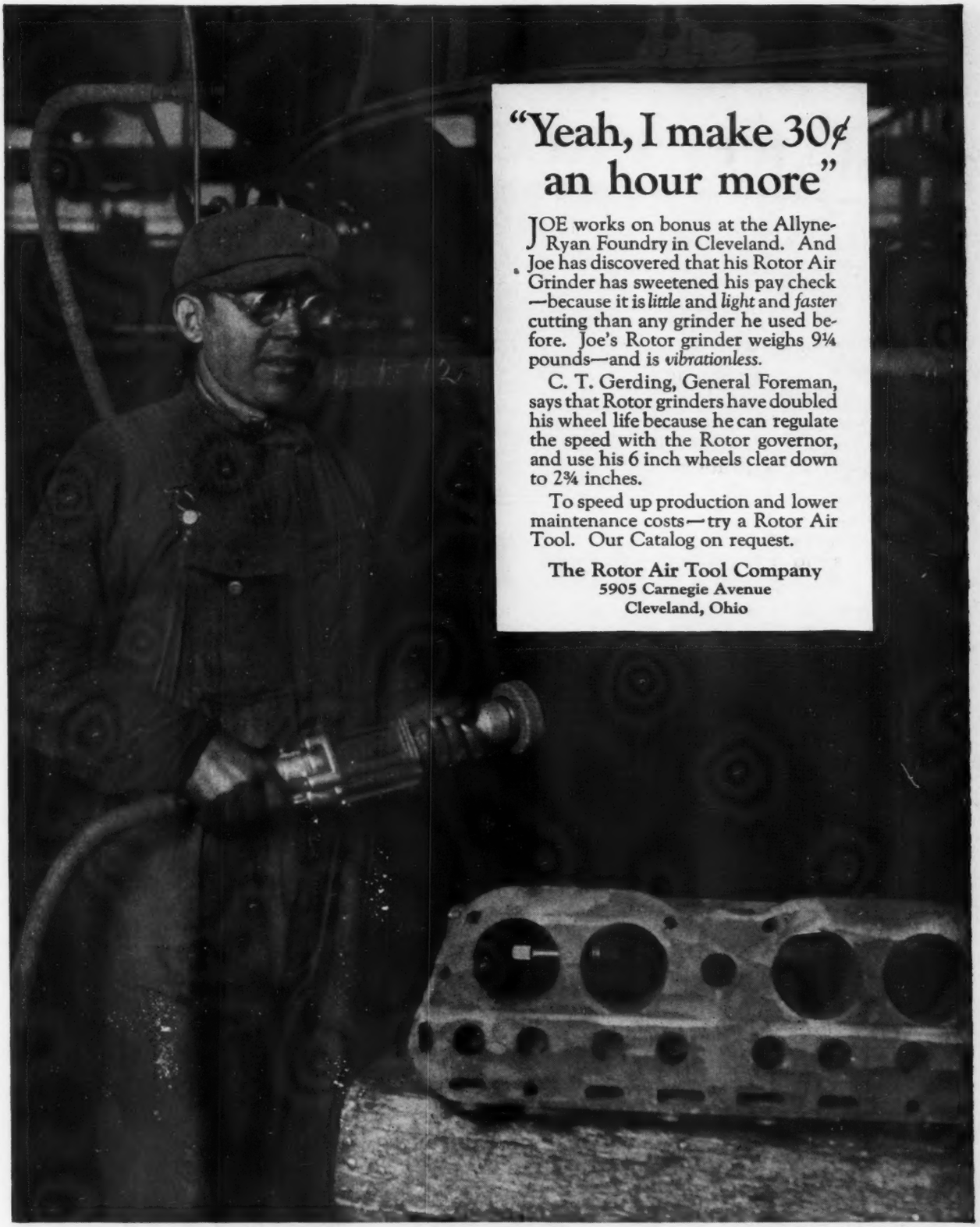

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JOE works on bonus at the Allyne-Ryan Foundry in Cleveland. And Joe has discovered that his Rotor Air Grinder has sweetened his pay check —because it is *little* and *light* and *faster* cutting than any grinder he used before. Joe's Rotor grinder weighs 9¼ pounds—and is *vibrationless.*

C. T. Gerding, General Foreman, says that Rotor grinders have doubled his wheel life because he can regulate the speed with the Rotor governor, and use his 6 inch wheels clear down to 2¾ inches.

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Rotor Air Tools

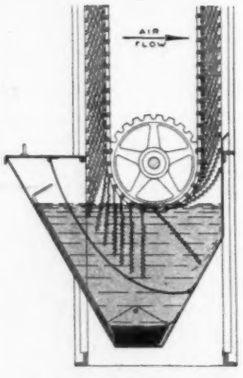
Left: Four 3-Unit Reed Type S. C. F. Filters with weather louvres used by one of the large oil producing companies to protect four Miller Gas Engines (name on request).

20 MAKERS RECOMMEND REED

The Reed Continuous Filter—built especially for heavy-duty, uninterrupted service on engines and compressors. *No personal attention required.*

Air Filters for *Every* Engineering Need

OVER 90% of all the oil-engine and air-compressor manufacturers in the United States recommend Reed Air Filters for use on their equipment. They know that Reed Filters are high in cleaning efficiency, low in resistance to air flow *and are built to give lasting service even under the severe conditions and pulsating air flow always encountered in this field.*



As the filtering screen of the Continuous enters the oil, the panels are automatically separated, cleaned individually and again reassembled. Positive self-cleaning is secured by forcing the panels through the oil.

A Complete Line

Whatever your requirements, there is a Reed Air Filter that exactly meets your needs . . . *The new Reed Continuous*—self-cleaning, self-charging—entirely automatic. No personal attention required. Unaffected by air pulsations and sudden changes in air velocity . . . *The Type S. C. F.*—designed for periodic manual cleaning—now filtering millions of cubic feet for well-known users everywhere . . . *Reed Type E*—a small, compact filter for use on tractors, trucks and on small engines and compressors.

Write today for bulletin No. 120 describing all types of Reed Air Filters and giving list of prominent engine and compressor manufacturers who recommend Reed. Gladly sent, without obligation, together with full details about the Reed 90-day, money-back guarantee. Use the coupon.

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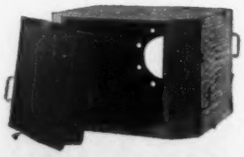
TRADE *filters* ALL METAL MARK



Reed Type S. C. F.—1800 C. F. M. capacity. The original American Air Filter employing the adhesive-impingement principle. Simple, economical, efficient.

Use This

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214 Central Ave., Louisville, Kentucky

Send, without obligating us, Bulletin No. 120 and full details on your 90-day, money-back guarantee.

Name..... City..... Possible Use.....

Company..... State .....

More and more Repeat Orders for Gas+Air BUCYRUS-ERIES

You've never before seen such remarkable records from any gasoline shovel, crane and dragline.

And that's why the list of ***repeat orders*** for Gas+Air machine is growing so fast. Here are some of the hundreds of Gas+Air owners whose ***second*** or ***third*** Gas+Air machines have been bought in 1928:

	Gas+Air machines now owned	Total number of BUCYRUS-ERIES
George M. Brewster & Sons Co., Bogota, N. J.	2	13
Morrison-Knudsen Co., Boise, Idaho	3	12
Lewis Construction Co., Los Angeles, California	2	2
Gaines Brothers, Fairland, Oklahoma	2	3
Ralph Witmas, Bovey, Minnesota	2	2
R. J. Kapphahn Contracting Co., Duluth, Minnesota	2	2

and more!

	Gas+Air Machines now owned	Total number of BUCYRUS-ERIES
James Turecamo Contracting Co., Brooklyn, N. Y.	2	4
Richard Hopkins Company, Albany, N. Y.	3	4
Wayne County Road Commission Detroit, Mich.	3	4
Ventura Excavating Company, Ventura, Calif.	2	3
Ellis & Brantley, Owensboro, Ky.	2	5

ONE GAS+AIR SELLS ANOTHER—because it's the fastest and most powerful gasoline shovel, crane and dragline built.

As the Gas+Air has direct connected, air operated engines for crowding and swinging, it can be worked ***much faster*** without the least jerk or jar. An air cushion protects this faster machine.

Write us for some output records made by Gas+Air BUCYRUS-ERIE shovels, cranes and draglines. The latest Gas+Air has numerous improvements in details—this tried and tested machine is thoroughly reliable.

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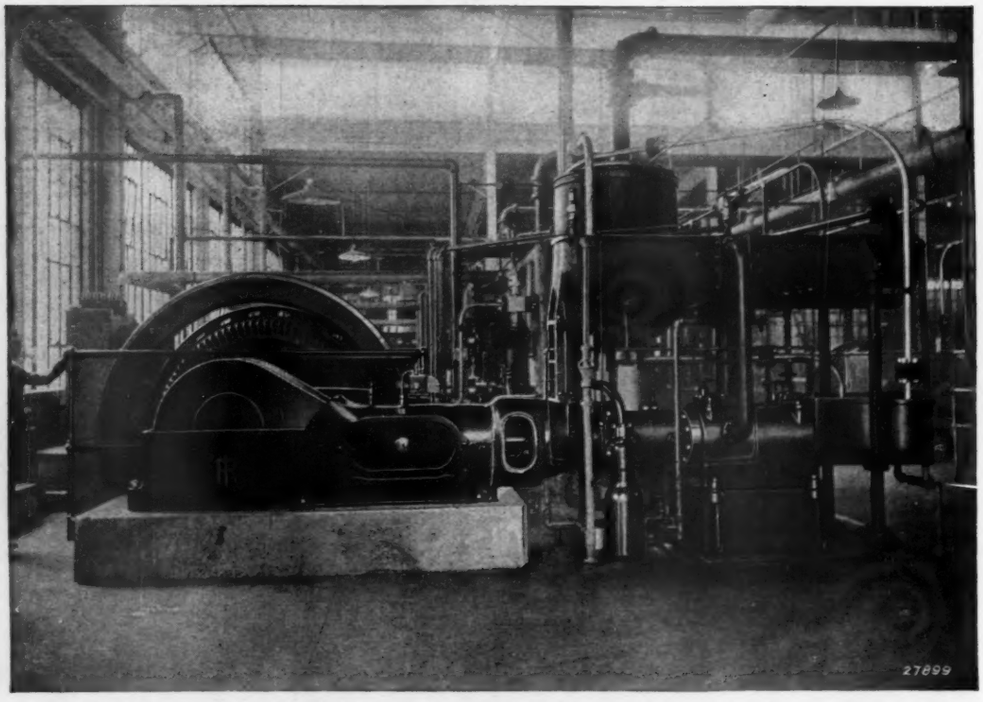

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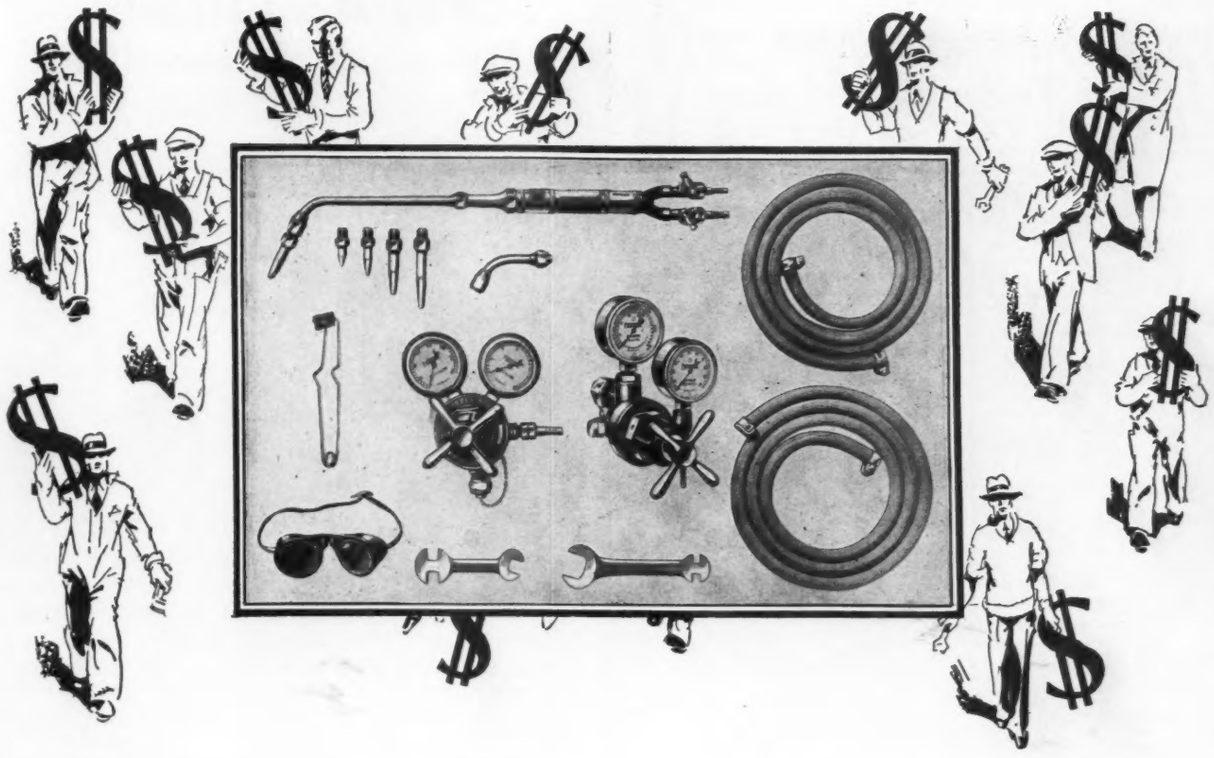

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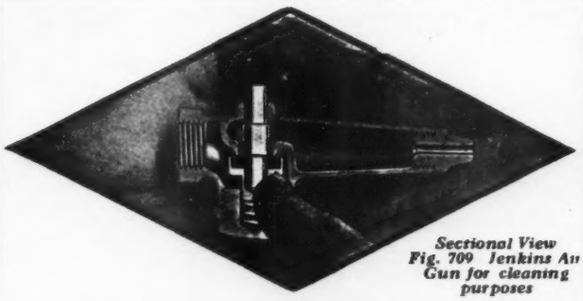

Sectional View Fig. 709 Jenkins Air Gun for cleaning purposes

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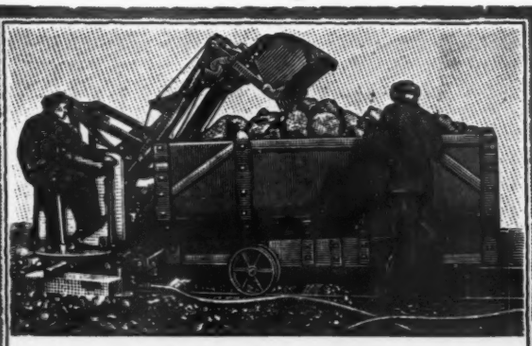

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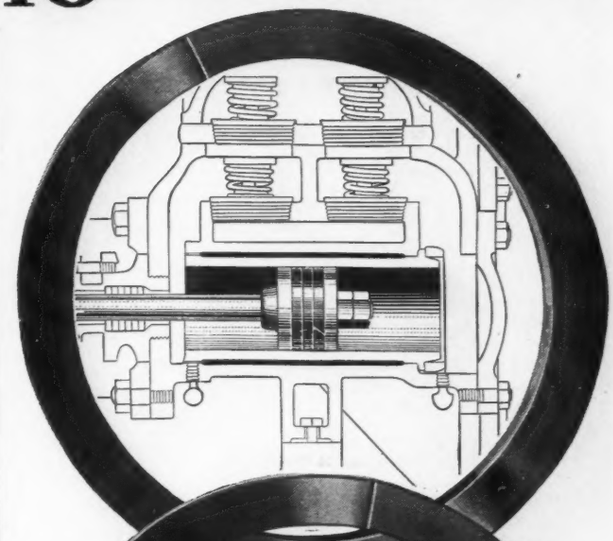

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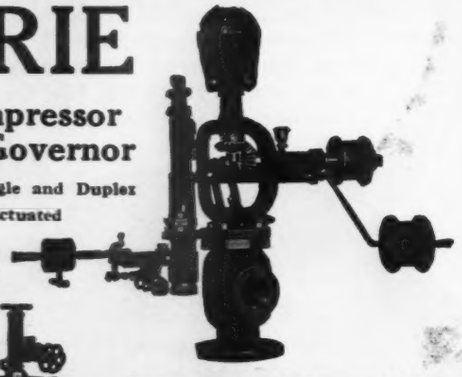

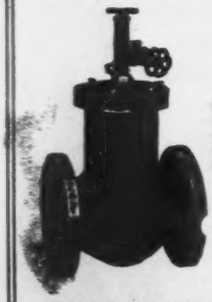

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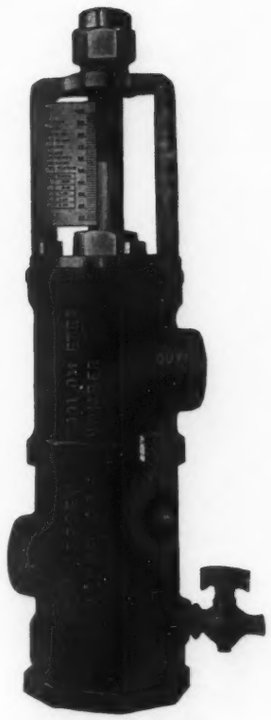

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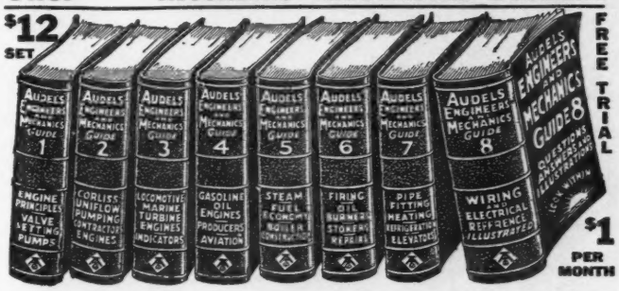

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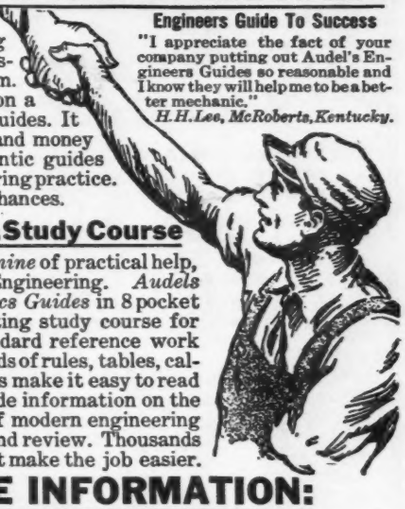

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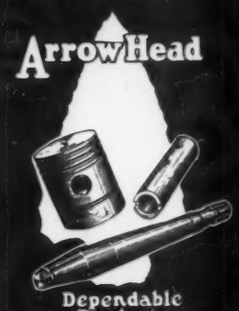

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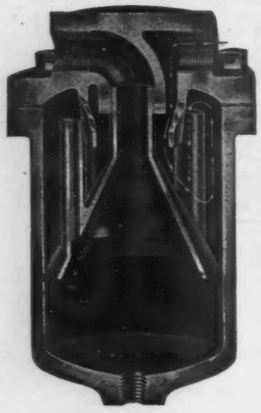

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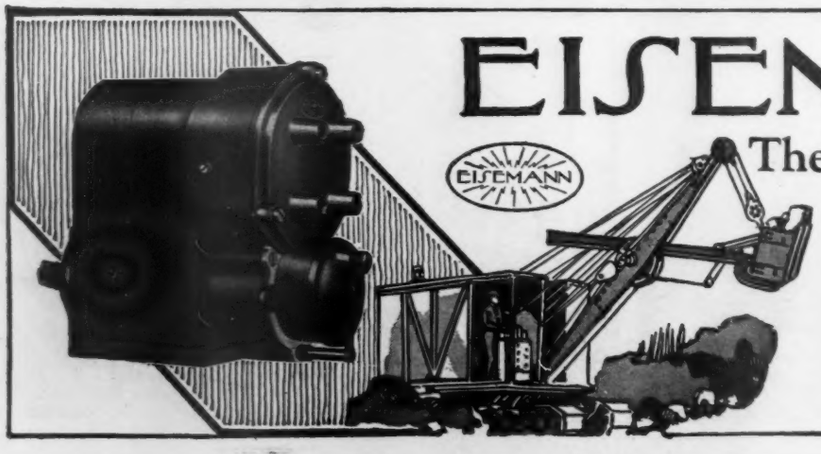

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The Ingersoll-Rand equipment at the Hecla Mine consisted of Drifter Drills, "Stopehamer" Drills, Compressors, "Little Tugger" Hoists, Cameron Pumps, Sharpeners, Drill Steel, etc.

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General view of the plant of the Hecla Mining Co. This property produced over two million ounces of silver in 1927.

The automatically rotated, R-51 "Stopehamer" did much towards making the splendid records at the Hecla Mine.

68-SD

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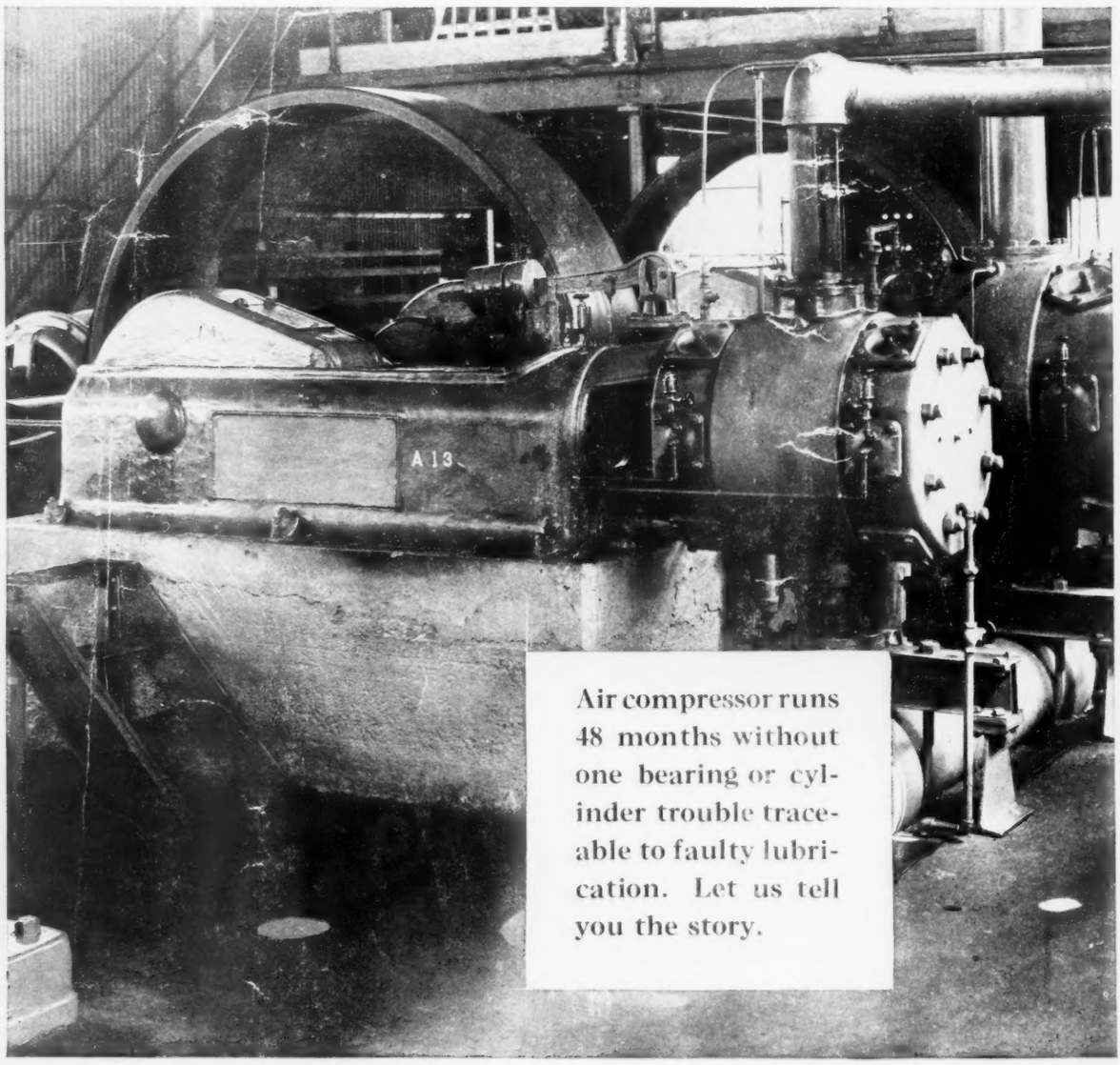

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